JUL 7 1924

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MACHINERY

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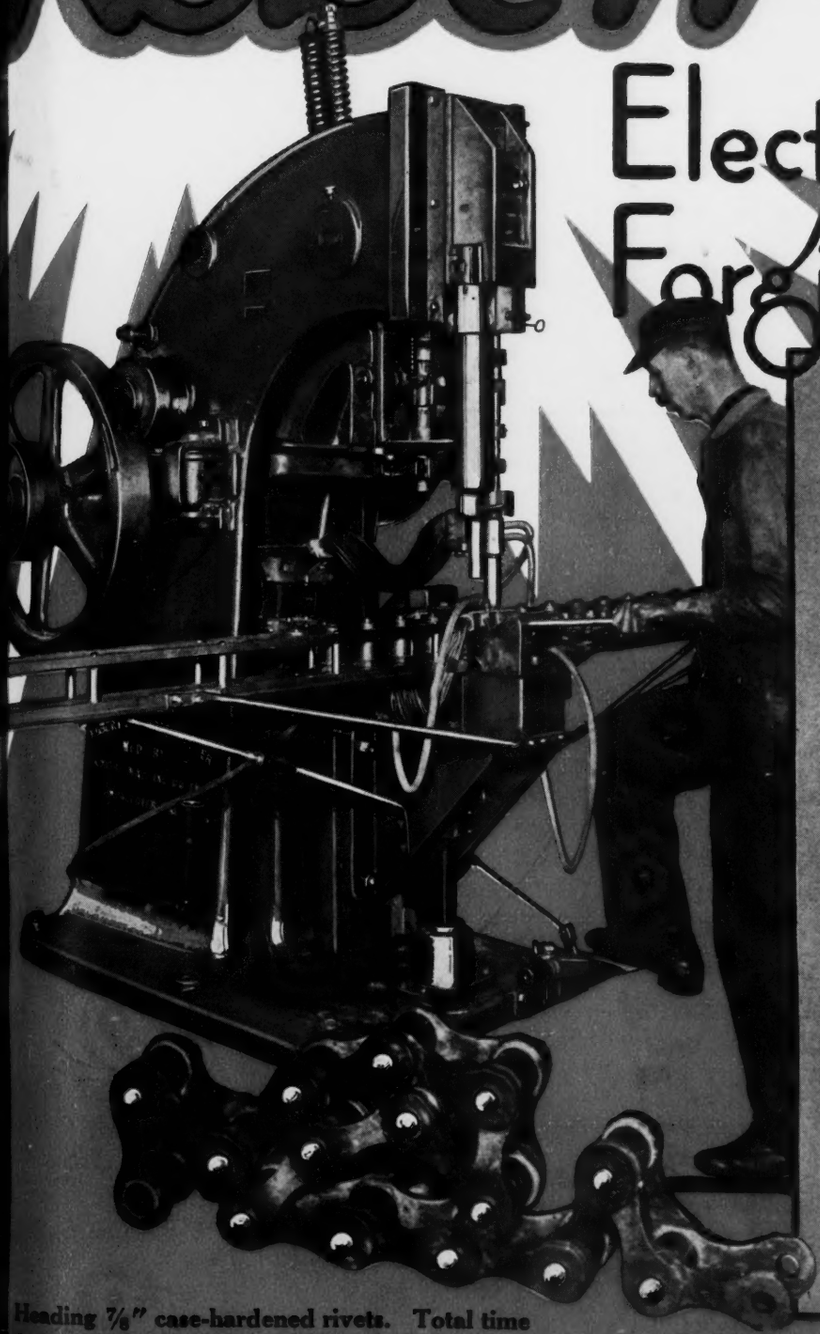
Kobert

Electric Heating, Forging, Riveting



Heading 7/8" case-hardened rivets. Total time 6 seconds each. Heat confined to rivet heads.

Place work in position—step on treadle—forging or welding temperature is reached in 1 to 5 seconds. Release treadle—machine does the rest. That, in general, is the operation of Kobert Machines.

Electricity for heating provides absolute temperature control, economical expenditure of energy and practically eliminates formation of scale.

Kobert Machines for riveting produce work as fast or faster than cold riveting; as good or better than hot riveting. On certain classes of work upsetting and forging on Kobert Machines are better, faster and more economical than the best production methods now in use.

Moreover—the Kobert "heat-and-hit" principle provides manufacturers with an *entirely new process* for making many articles complete at one operation. Important, and worth investigating.

KOBERT MACHINE CO.
INCORPORATED
WORCESTER MASS., U. S. A.

"BRISTO"

Safety Set Screws

A Handful of Efficiency

Hard outside and different inside!

That's why "Bristo" Safety Set Screws hold long service records. Hard outside because special methods of heat treatment insure resistance to the wear of frequent tightening and loosening; different inside because dovetail flutes are an exclusive "Bristo" feature.

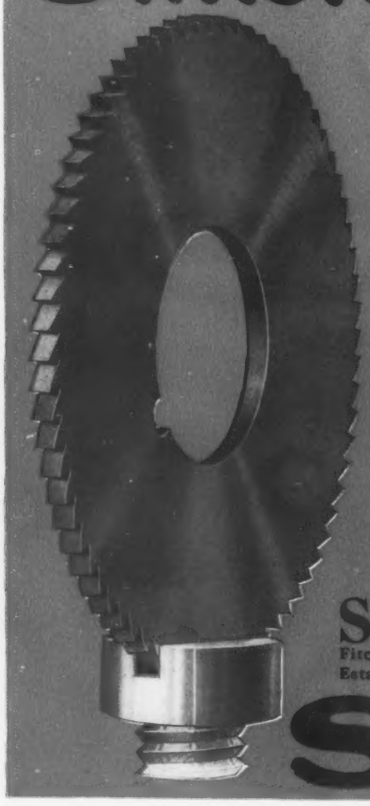
You don't know what a big difference dovetail flutes make until you've tightened a "Bristo" Safety Set Screw hundreds of times and find the wrench fitting as snugly as ever!

You cannot get that kind of service from a set screw in which the wrench will wobble at the first sign of wear. Use "Bristo" Safety Set Screws and notice the difference.

Bulletin 811-E and samples on request.

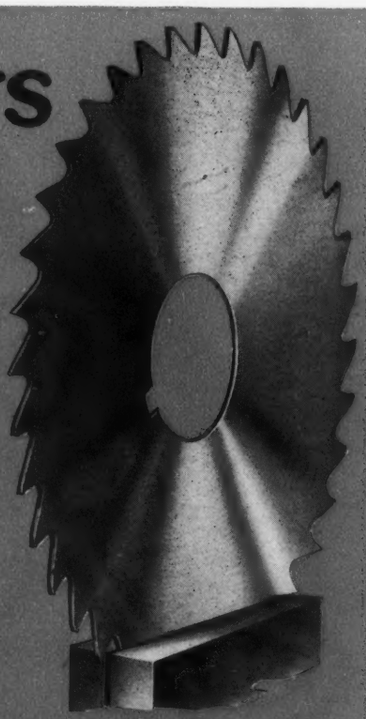
THE BRISTOL COMPANY
WATERBURY, CONN.

Slitters and Slotters



Simonds Semi-High Speed Steel Slitters serve a double purpose. Besides being used for metal slitting they are also practical saws for light cut-off work. They give much greater service than ordinary carbon slitters and have nearly all the cutting qualities of High Speed Steel Slitters, costing three times as much.

Simonds Screw Slotting Cutters are also as efficient for their particular duty.

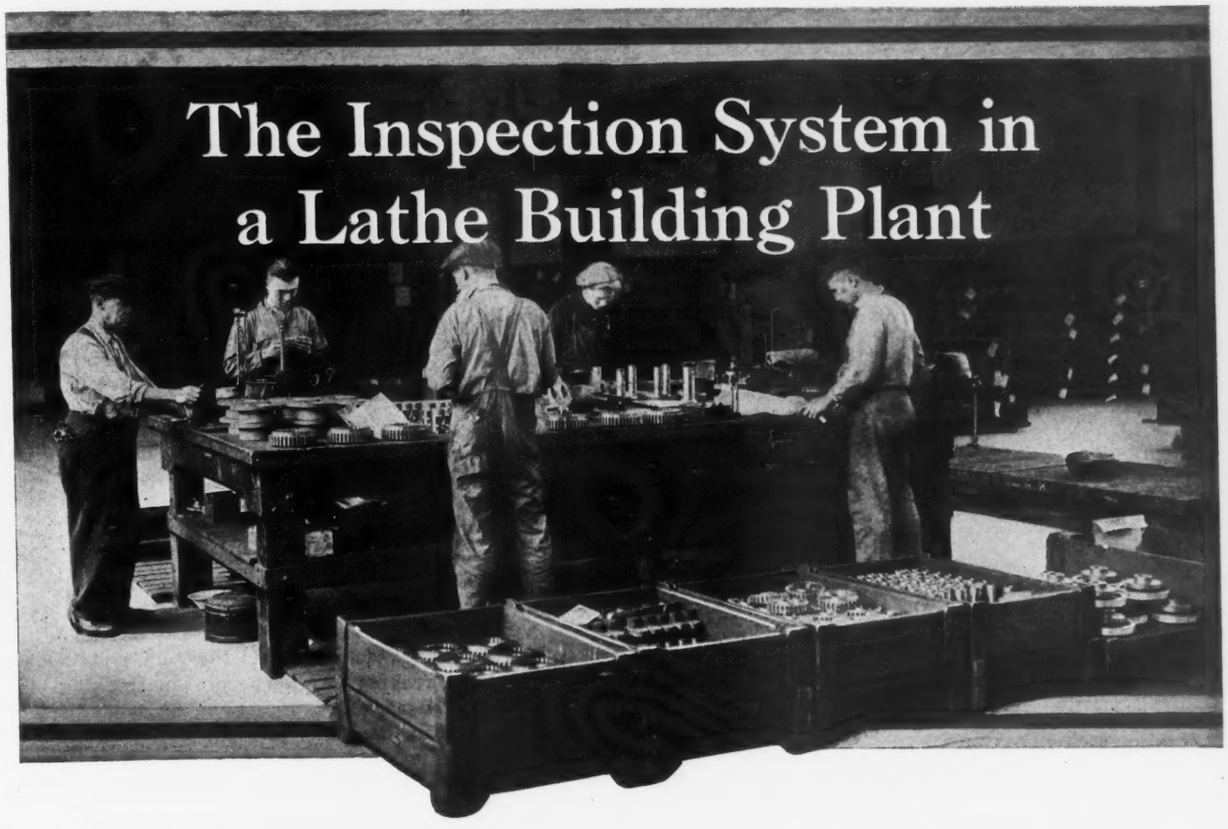


Write for catalog and prices.

Simonds Saw and Steel Co.
Fitchburg, Mass.
Established, 1832
Chicago, Ill.
5 Factories

SIMONDS

The Inspection System in a Lathe Building Plant



Checking the Accuracy of Lathe Parts, Assembled Units, and the Completed Machines

By H. S. RIGGS, The Lodge & Shipley Machine Tool Co., Cincinnati, Ohio

YEARS ago little consideration was given to the inspection of work. If parts did not go together when they came to the assembling bench, they were altered to suit. Obviously under such methods of manufacture there was a great loss of time in assembling. Today, however, the old methods have been replaced in up-to-date plants by inspection systems that insure high precision. A standard of accuracy is set for all important dimensions and quality of finish, and a corps of inspectors is employed to see that the standards are maintained. The system followed at the plant of the Lodge & Shipley Machine Tool Co., Cincinnati, Ohio, to determine whether the parts are within specified limits, both when they come from the machine and after being assembled into units, and to test the accuracy of the completed lathes is described in the present article. The entire procedure will be explained from the time the raw materials are received.

Purpose of the Traveler Tag

When it has been decided to start manufacturing a quantity of certain parts, a traveler tag, such as illustrated in Fig. 1, is filled out to show all the operations required, and this tag is sent to the receiving office. When the rough forgings or castings are received, this traveler tag is attached to one piece of the lot, and the lot is then sent to the department that is to perform the first operation specified. The foreman of that department gives out the work in the sequence that it is issued to the job, this being determined from "ticklers" which contain complete information about each job, including the date issued to the shop, which appears in large figures. Before any work is done, the raw material is carefully inspected for defects. The operator who receives the job takes the traveler tag to the time desk near his department and is "rung in" for the job. The operator next machines one piece of the lot and has the foreman check it against a detail blueprint that accompanies the job. The reason for this checking is twofold—first to see that the job is done strictly in accordance with the blueprint, and second to see that the machine set-up is the best possible. The foreman can often suggest different feeds or speeds, the use of different tools, etc. By checking work in this manner, trouble is usually averted, because with a correct start the chances of the operator making a mistake on the lot are small.

If the first piece has been machined correctly and the operator apparently understands what is required, he is allowed to proceed with the entire lot of parts. When the lot is finished, the operator again takes the traveler tag to the time desk and is "rung out." The parts are then put into a tote box, which is placed on a lift truck platform and set into the "move station" of that department, indicated by broad white lines painted on the floor. Anything set in the "move station" is an indication that it is ready to be removed to the central inspection department, which is done by employing a storage battery tractor. This inspection department is shown in the heading illustration. (An article describing the transportation system in this plant appeared in February MACHINERY).

Work of the Central Inspection Department and the Stock-room

In the central inspection department, all parts are given a thorough examination, and after this has been completed, the inspector punches the traveler tag in the column headed "Inspector," opposite the operation inspected. Then the box is set in the "move station" to be taken to the department

MAKE FOR	71953 R-262-3-4 D-18" Change Gears & Quadrant	SHOP NO.	72060
	Change Gear Shaft Large Gr. DF.	SYM. & PIECE NO.	D-666
		QUAN.	40

Spoiled or Defective Not Replaced							Detachments		A	B	C	D	E
QUAN.							QUAN.						
OPER.							OPER.						

	INSPECTOR
B-1 Bore ream & face	
G-2 Keyway	
BB-3 Grind other face	
TT-4 Inspect & Demagnetize (No PT)	
C-5 Turn tl# V-865,10273	
C-6 Round	
H-7 Gear cut (Fellows) Tl# V-42	
D-8 File burrs	
Q-9 Paint (1 coat)	
to stores	

MAKE FOR	71953 R-262-3-4 D-18" Change Gears & Quadrant	SHOP NO.	72060
	Change Gear Shaft Large Gr. DF.	SYM. & PIECE NO.	D-666
		QUAN.	40

USED

LEAVE BLANK FOR COST

VEN.	WGT.	COST EA.	VALUE	RECORD

C. C NR. W. B.

USED	A/C. NO.	QTY.	RATE

Detach	A	B	C

STORES DATE

TRACER

RAW CONTROL

FIN. CONTROL

FIN. PTS. LEDGER

STORES LEDGER

COST RECORDS

Fig. 1. Traveler Tag which accompanies Each Lot of Parts

for performing the next operation specified on the tag. Each inspector has a punch that produces a different style of mark, so that if any question regarding inspection develops later, it can quickly be determined which man is responsible for the various operations. It may seem troublesome to bring each lot of parts to the central inspection department after every operation, but the trouble is offset by having less work consigned to the scrap heap. This method makes it practically impossible for a department to do work on parts that have been incorrectly machined in a previous operation, and hence the number of spoiled parts due to defective workmanship is cut down to almost nothing.

If, however, anything develops that makes it necessary to throw out parts, due either to defective material or workmanship, the inspector's scrap order shown in Fig. 2 is made out and a new lot of parts is ordered to replace the defective pieces; but this seldom occurs on account of the careful inspection outlined and the close supervision of the foremen. In every department throughout the shop, there is hung in a conspicuous place, a sign which tells the machine operators why defective work is costly. It drives home the fact that spoiled work affects the operator as well as the firm, and it sums up concisely the way in which each operator can avoid spoiling any job.

When parts are scrapped, it means greater loss than is at first apparent. In the first place, some incomplete machines are generally held up on the erection floor, thus tying up considerable capital. Then, again, the job of getting additional parts through the shop means double effort and expense. Getting quick delivery from the foundry is not always easy, and rushing the work through the shop, the special supervision necessary, and the breaking up of shop routine and existing schedules, all make it desirable to take extra precautions to prevent spoiled work. In order to allow for defective castings and take care of any shortages that may develop, a few extra pieces are usually run with each lot of parts. It is the spoiling of work in machining that causes wrinkled brows, and the importance of eliminating this cannot be over-emphasized.

When the last operation called for on the traveler tag has been performed and the parts have been finally inspected, they are taken to the stock-room, where they are held until requisitions are sent out by the works office. The stock-keeper fills such requisitions, and sends the parts to the foreman of the assembly department.

In the event that there is not sufficient stock to fill the requisitions, the stock-keeper sends out the parts on hand and fills out green shortage slips for the parts that are to follow. These shortage slips are filed in a rack by the assembly foreman and removed as the orders are filled. Thus a check can be made at any time on the parts that are short.

Inspection in the Assembly Department

After the units of a lot are assembled, the foreman sends for an inspector to check them. The reason for having the inspector come to the work instead of taking the work to him, is that it is quite a job to haul large units around the shop, and it is easier for the inspector to check them in the department where they have been assembled. Any necessary corrections can also be made more quickly in the assembly department.

When a unit passes inspection, the small card shown in Fig. 3 is attached to it. This card is made out in duplicate and folded at the center. The units are then sent to the stock-keeper, who tears off the duplicate tag and sends it to the perpetual inventory desk as an indication that this particular unit is finished and in stock. This gives a complete check-up at all times on the units in stock. From the foregoing it will be understood that the inspection system consists, briefly, in sending the detail parts to a central inspection department after each operation and sending an inspector to the assembly department for the unit inspection. However, a complete test is also given each lathe after erection.

Testing Lathes after Erection

The use of jigs, templets, etc., for manufacturing each size of lathe on an interchangeable basis makes it possible to erect the machines without having to fit and try each unit. Under such manufacturing conditions, a lathe can be built, torn down, and rebuilt with other units from stock, and it will have its original accuracy. Thus it will be seen that the close inspection of units bears fruit in making interchangeability a reality. This is particularly valuable when repair and other parts are sent to a customer after the lathe has been shipped.

An erection tag such as shown in Fig. 4 is hung on each lathe when erected. This tag is filled out in quadruple, the original being kept as a record by the engineering department, the second copy going to the cost department, the third being used by the inspector, and the fourth accompanying the lathe. These copies are practically the same, with the exception of that sent to the cost department, which is arranged on the back as shown in Fig. 5. The backs of the original and the third copy are blank, but the fourth copy gives a few instructions to the customer. Each unit incorporated in a lathe has a construction number marked on it corresponding to a number on the drawings of the unit. These construction numbers are carried on the erection tag for record purposes.

After the lathe is built, there is no inspection until the machine reaches the testing floor, where it is put through exhaustive tests. Altogether about thirty-six steps constitute the final testing and inspection of the lathes in this shop. In order that a clear conception may be had as to just what is done, these steps will be enumerated in the following:

1. The lathe is placed under a motor, with a belt in place on the motor pulley, and is lined up for driving. The motor is fastened to an overhead shelf, and by having the belt on the motor pulley when the machine is set in place, the operator can get the proper tension on the belt. The belt should not run too close to the side of the lathe pulley, because if it does it is likely to climb the flange or slip off the driving pulley.

2. The reverse plate cover is removed so as to see whether the gears mesh properly and whether the gear studs are satisfactorily oiled. The spindle nut at the left-hand end of the headstock is also adjusted at this time.

3. All dust and oil is cleaned off the ways of the bed and from other exposed finished parts of the machine. This is done before leveling the machine or running the carriage or tailstock over the surfaces, which would result in cutting or scratching the surfaces if they were not cleaned.

4. The machine is leveled by placing a leveling plate on the ways near the headstock and applying a level. Wooden wedges are then driven under the legs until the lathe is level at that point. The plate is next removed, and the entire bed is leveled up. After the last adjustment of the wedges, the machine is checked all over to insure that there is no twist in the bed.

5. All oil-holes, tubes, and similar parts are inspected thoroughly to see that they are free from dirt, waste, etc., and then the lathe is oiled. It is of vital importance to see that all oil-holes are open. The oil put on parts when they are assembled is sufficient to keep them in running order while the lathe is being aligned and inspected, but it must not be assumed that all oil-holes are open because of the presence of oil. After a lathe has been in service a short time, trouble is likely to develop if any holes are stopped up, and, of course, in such circumstances the workmanship would be blamed.

INSPECTION CARD

Name Ch. Grs. & Quad.

Shop No. 72060

Stamp or Piece No. D-666

Size 18"

Quan. 40

Inspected

Remarks

582

Fig. 3. Card showing that Unit has passed Inspection

Machining and Checking the Front of the Faceplate

6. A roughing cut is taken over the faceplate and the corners are rounded to eliminate sharpness and improve the appearance. Both the large and small faceplates are turned and faced on the lathe on which they are to be used.

7. A finishing cut is taken across the faceplate, as shown in Fig. 10, but before this, the set-screw in the spindle nut is loosened and the nut tightened just enough to make the spindle feel "close" when revolving it by turning the faceplate. After the faceplate is finished, the spindle nut is again loosened about one-eighth of a turn and the set-screw retightened. Then the spindle is hit a light blow on the left-hand end with a soft hammer to ease it up.

8. The faceplate is tested for straightness. This is done by applying a straightedge across the center of the faceplate, as shown in Fig. 11, with four strips of tissue paper placed under the straightedge about equal distances apart. Each of these strips is pulled to determine which are loose, if any. The outer ones must be tight as the faceplate must never be convex. It must either be straight or not more than 0.001 inch hollow.

9. The compound rest is aligned. In this step the clamping bolts *A*, Fig. 6, are loosened on the swivel base, and then, with a straightedge placed across the faceplate, the side of the tool-slide is brought against the straightedge by feeding the carriage by hand. To make sure that the tool slide is parallel with the straightedge, the latter is moved slightly. Then the clamping bolts are tightened, and a short scale and scribe are used to make a zero mark on both sides of the compound rest at *B* to register with the graduations on the base of the compound rest.

10. The faceplate is removed.

Testing the Alignment of the Headstock and Tailstock

11. The taper hole in the spindle is polished while the spindle is in motion by applying a worn piece of emery cloth, and it is then cleaned out with a piece of waste.

12. The accuracy of the taper hole in the spindle is tested. In this step, an aligning bar, 18 inches long, is placed loosely in the hole and held firmly to keep it from turning with the spindle. An indicator is then brought in contact with the overhanging end of the bar, and the spindle rotated. Any movement of the indicator, of course, shows an error in the spindle hole. The limit of error is 0.001 inch at the extreme end of the aligning bar.

FILL THIS FORM IN DUPLICATE

INSPECTOR'S SCRAP ORDER MAKE FOR 71953

SHOP NO. 72060 DET. B

SYM. & PIECE NO. D-666

QUAN. ON ORDER 40

QUAN. SCRAPPED 2

NAME Chg. Gr. Shaft Large Gear

ASSEMBLY NAME Chg. Gr. & Quad. MATERIAL DF (If cut off give dimensions)

SCRAPPED BECAUSE Defective DUE TO Blow holes

BY CHECK NO. Forge Co. DEPT. DATE 3-21-24

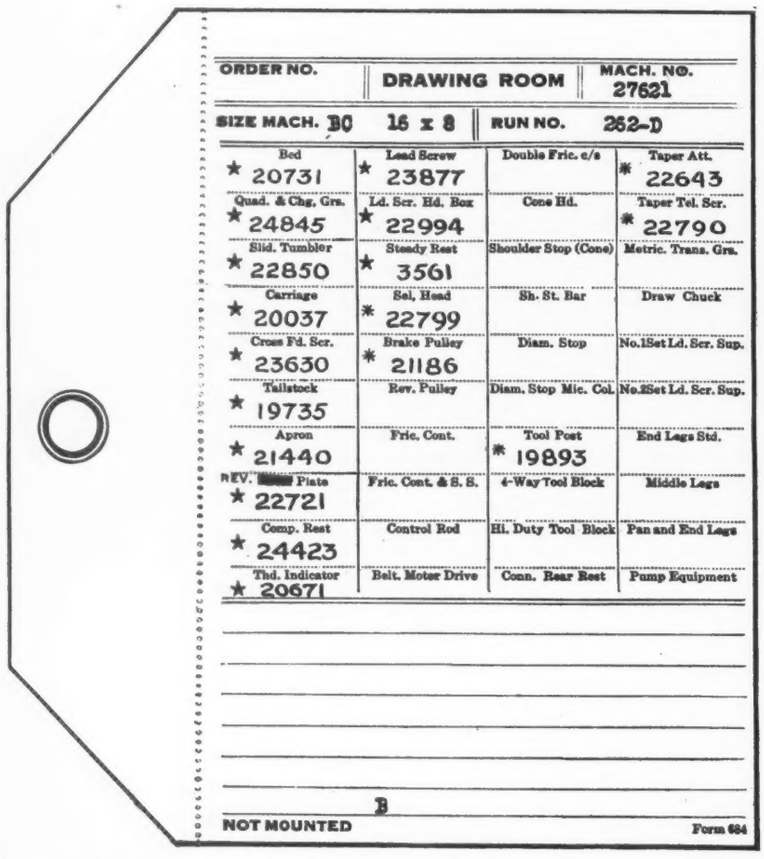
SIGNED Thomas OPER. WHEN SCRAPPED B-1

DO NOT WRITE BELOW THIS LINE IN SHOP

REPLACE				
By Trade at Stockroom	On Same Shop No.	By Raising Shop No.	Not Replaced	
				HOURS WAGE
				BURDEN
				MATERIAL
				TOTAL

Form 514

Fig. 2. Form filled out by the Inspector when Parts must be scrapped



ORDER NO. | DRAWING ROOM | MACH. NO. 27621

SIZE MACH. B0 16 x 8 | RUN NO. 262-D

Bed ★ 20731	Lead Screw ★ 23877	Double Fric. c/s	Taper Att. * 22643
Quad. & Chg. Grs. ★ 24845	Ld. Scr. Hd. Box ★ 22994	Cone Hd.	Taper Tel. Scr. * 22790
Slid. Tumbler ★ 22850	Steady Rest ★ 3561	Shoulder Stop (Cone)	Metric. Trans. Grs.
Carriage ★ 20037	Sel. Head * 22799	Sh. St. Bar	Draw Chuck
Cross Fd. Scr. ★ 23630	Brake Pulley * 21186	Diam. Stop	No. 1 Set Ld. Scr. Sup.
Tailstock ★ 19735	Rev. Pulley	Diam. Stop Mic. Col.	No. 2 Set Ld. Scr. Sup.
Apron ★ 21440	Fric. Cont.	Tool Post * 19893	End Legs Std.
REV. [illegible] Plate ★ 22721	Fric. Cont. & S. S.	4-Way Tool Block	Middle Legs
Comp. Rest ★ 24423	Control Rod	Hl. Duty Tool Block	Pan and End Legs
Thd. Indicator ★ 20671	Belt. Motor Drive	Conn. Rear Rest	Pump Equipment

B

NOT MOUNTED Form 684

Fig. 4. Erection Tag made out in Quadruple for the Engineering Department, Cost Department, Inspector, and Customer

13. The alignment of the headstock spindle with the ways of the bed is determined. The aligning bar is now pushed solidly into the taper hole of the spindle, and any error in the bar and spindle is divided by placing at the top the side of the bar having the maximum error. The indicator is then run the full length of the bar along the front. The limit of error is again 0.001 inch at the extreme end of the bar, and the error must be such as to cause the bar to point toward the front of the machine.

14. The levelness of the headstock spindle with the ways of the bed is tested, the spindle being turned so that the side of the bar that was at the front in the preceding step is now on top. Then the indicator is again run along the full length of the bar on the top. The limit of error in this case also is 0.001 inch at the extreme end of the bar, and the error must be such as to cause the bar to point upward.

15. The aligning bar is removed and the taper bushing tested for a proper fit in the spindle hole. This is done by covering the bushing with a light coating of red lead and inserting it into the spindle hole. An effort is then made to move or shake the bushing by hand, after which it is removed and examined for high spots.

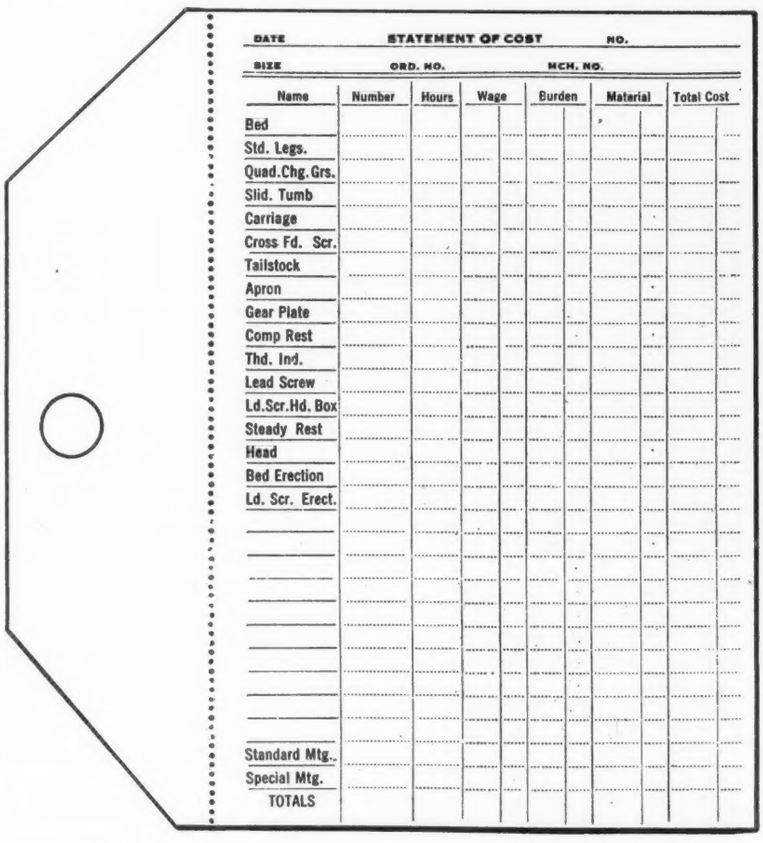
16. The headstock center is tested for trueness by placing an indicator against the point, as shown in Fig. 7, while the center is running. No appreciable error is allowed in this test. Before it is conducted, the center is carefully examined to make sure that it is clean.

17. The tailstock center is tested for fit in the tailstock spindle by putting a thin coating of red lead on it and turning it by hand in the spindle. After removal it is carefully inspected to see if any high spots are indicated.

18. The alignment of the headstock and tailstock is tested. The tailstock spindle is run out 4 inches, and a test bar placed between the headstock and tailstock centers. Then the indicator is run along the side of the bar at each end, the tailstock being set over, if necessary, to line the center up with the headstock center. The indicator is next run over the top of the aligning bar at each end to test the height of the tailstock center in relation to that of the headstock. Then the tailstock spindle is run out the full length and tested on top for alignment. It should align with the headstock or not be over 0.001 inch higher. The tailstock spindle must be parallel with the ways.

19. A mark is scribed on a boss at the rear of the tailstock top casting. This is done when the tailstock has been aligned, a straightedge being used in connection with a steel scribe to produce the mark opposite the zero line on the tailstock base.

20. The sliding tumbler of the speed gearing is tested in all positions to make sure that the plunger-pin *C*, Fig. 9, drops easily into all holes and that all gears mesh properly. If the plunger-pin must be forced into a hole, it shows that the gears mesh too closely. The tumbler should have 1/32 inch free movement before the plunger-pin drops into place; that is, the tumbler should rise 1/32 inch higher than necessary to allow the plunger-pin to drop into place. However, if the rise is more than 1/32 inch, the gears will be noisy. The machine is then run with the plunger-pin in all positions.



DATE STATEMENT OF COST NO.

SIZE ORD. NO. MCH. NO.

Name	Number	Hours	Wage	Burden	Material	Total Cost
Bed						
Std. Legs.						
Quad. Chg. Grs.						
Slid. Tumb						
Carriage						
Cross Fd. Scr.						
Tailstock						
Apron						
Gear Plate						
Comp Rest						
Thd. Ind.						
Lead Screw						
Ld. Scr. Hd. Box						
Steady Rest						
Head						
Bed Erection						
Ld. Scr. Erect.						
Standard Mtg.						
Special Mtg.						
TOTALS						

Fig. 5. Reverse Side of Copy of Erection Tag used by Cost Department

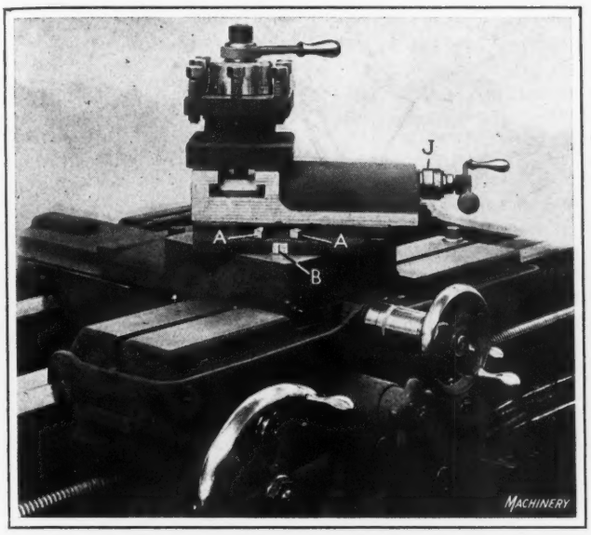


Fig. 6. Illustration showing Position where Line is scribed on the Compound Rest Swivel

21. The lead-screw head-box push-pin *D*, Fig. 9, is tested in all four of its positions, and special care is given to see that ball grooves *E* on the pin are properly spaced to allow the quadrant to come into position. The machine is then run with pin *D* in all of its positions.

22. A piece of emery cloth is used to draw-polish the lead-screw on portion *F* as far as the keyway extends. The lead-screw is turned a little at a time until polished all around. The machine is then started, and portion *G* in front of the keyway is circle-polished.

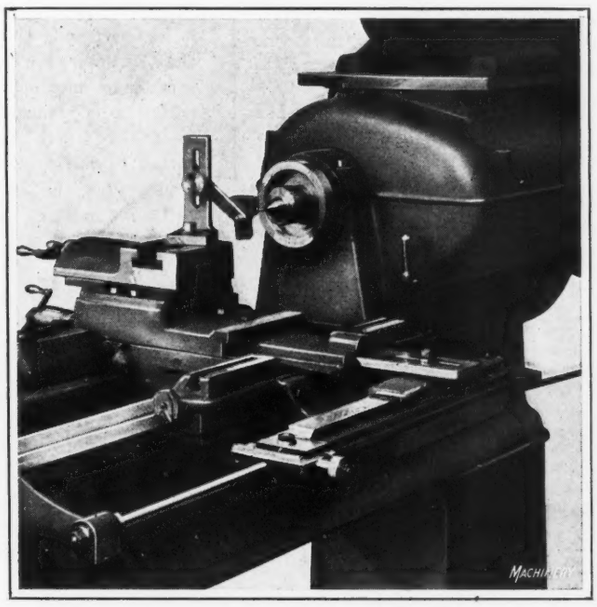


Fig. 7. Testing the Accuracy of the Headstock Center

23. The clutch shaft and collar and the lead-screw at *H* are polished, these steps materially enhancing the appearance of the machine.

24. The nut on the left-hand end of the headstock spindle is polished, a file being used for rounding the corners and a piece of emery cloth for polishing.

25. The back and center clamps on the carriage are adjusted, being drawn up just tight enough to lock the carriage. The screws are then loosened one-eighth of a turn on both the back and center clamps. The carriage is next run from the head end of the machine to the tailstock end to make sure that the bed is parallel and that the clamps do not bind at any point. This is done by hand so that any tight spots may be felt.

26. The rack and pinion are tested for character of teeth and mesh. This is done by running the carriage up and down along the bed by hand to see if the pinion works freely in the rack. The carriage will tend to bind if there are thick teeth in the rack or pinion, or if the teeth are meshed too deeply. On the other hand, it is equally important that

587 500-4-19-W

INSPECTION CARD.

Lodge & Shipley Machine Tool Co.

Size Machine 16x8

Order No. 19680 Shop No. Sel Machine No. 27621

All Tests Made in Thousands

Spindle with Shear Points USE TEST ARBOR	Top	Up .001"	Aligned by
		Down	
	Side	Front .001"	
		Rear	
Tailstock with Head	Top	High	Aligned by
		Low .0005"	
	Side	Front	
		Rear 0	
Spindle with Cross Slide	Loose Front		Aligned by
	Straight		
Face Plate	Hollow .001" in 24 inches		Tested by
	Straight		
T/A with Shear	Parallel		
Back Gear Runs	0		
Bore of Spindle Runs Out	.00075 in 18 inches		
Bush in Spindle Runs Out	.00075 in 18 inches		
Chuck Runs			

Inspected March 31st 1924

By J. Schoedinger

See Reverse Side for General Inspection

Fig. 8. Final Inspection Card

the teeth mesh deep enough, as otherwise there will be too much play or backlash.

27. Attention is given to the lead-screw to see whether it is in line with the lead-screw box. With the carriage at the tailstock end of the bed, the lead-screw is turned by hand until the carriage reaches the headstock. The lead-screw will turn freely if it is in line with the box.

28. The reverse lever on the apron is tested to make sure that the bevel-gear stand in the apron is in line with the tail-end lead-screw box. After the carriage is run to

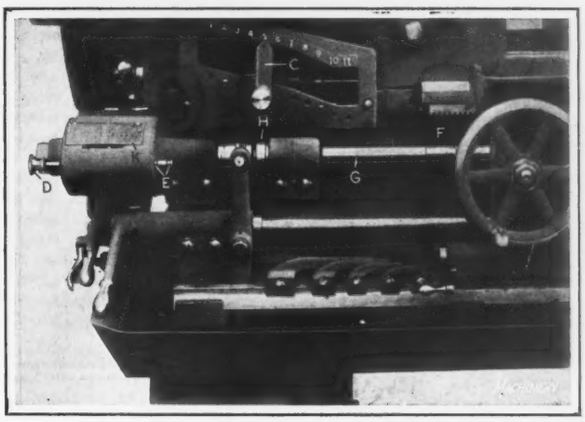


Fig. 9. Various Members inspected at the Head End of the Bed

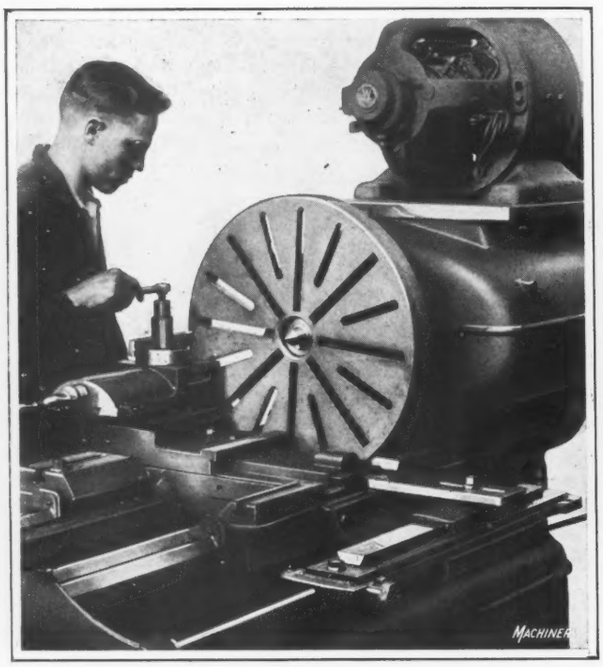


Fig. 10. Taking Finishing Cut across Front of Faceplate

Fig. 11. Testing the Trueness of the Front of the Faceplate

the tailstock end of the bed, the reverse lever is operated. If the lever is out of line, it will work stiffly because there will be a great amount of friction between the double bevel-gear and the lead-screw. The carriage is then run to the headstock end and tried in the same manner. If the bevel-gear stand is not in line, the tail-end lead-screw box will run hot during this test.

29. The half-nuts are closed on the lead-screw while the lathe is not in operation. If they do not close freely, it is an indication that they need attention.

30. A sliding gear on the headstock is tested for fit on its key, and the positions of the spots on the shaft for locating the sliding gear are checked.

31. The reverse gears in the headstock are tried by running in all ratios. They are also inspected to determine whether they clear the cover.

32. The micrometer collar *J*, Fig. 6, is inspected to make sure that all graduations are correct and properly stamped.

33. The lathe is inspected all over for finish of bright parts, attention being given to such things as bolt heads and nuts to see that they are not nicked and that they are all of the proper length. Special attention is given to the tailstock bolts, and the pads on the bed are inspected to see that they are chipped square and that all corners and edges are properly finished.

THE LODGE AND SHIPLEY MACHINE TOOL CO.
CINCINNATI, OHIO

LIST OF ARTICLES AND LOOSE PARTS PACKED WITH 16" x 8' Selective Head LATHE NO. 27621

Packed in Box	Article or Part	Packed	Shipped	Packed in Box	Article or Part	Packed	Shipped	Packed in Box	Article or Part	Packed	Shipped
	Apron Hand Wheel	1	1		Instruction Plates-English	1	1		Starter		
	Belt for Motor				Instruction Plates-French				Steady Rest	1	1
	Blue Prints	1	1		Instruction Plates-German				Steady Rest No. 1		
					Instruction Plates-Italian				Steady Rest No. 2		
	Brake Pulley			✓	Instructions to Operator	1	1		Switch		
	Can of Oil				Large Face Plate	1	1		Tail Stock	1	1
	Center Bushing	1	1		Lead Screw Support				Tail Stock Pinion		
	Center Leg				Length Stops				Taper Att.	1	1
✓	Center Oiler	1	1		Main Spindle Ball Thrust				Taper Pins for Motor		
	Centers 2	1	1		Metric Gears				Telescopic Screw		
	Chuck				Metric Screws				Thread Indicator	1	1
	Chuck, Draw-In				Motor				Tool Post Ring		
	Chuck Jaws				Motor Belt Guard			✓	Tool Post Step Collar	1	1
	Chuck Plate				Motor Plate				Tool Post Wedge		
	Chuck, Quick Catch				Oil Gauge				Turret on Bed		
	Coarse Thread Attachment			✓	Oil Hole Cover for Head 2	1	1		Turret on Bed Power Feed		
	Collets				Pan				Turret on Carriage		
					Plain Swivel Rest				Turret Tool Post		
	Compensating Nut				Pulley for Motor				Water Pot		
	Compound Rest	1	1		Pump and Tubing			✓	Allen Wrench 2	1	1
✓	Compound Rest Handle	1	1		Pump and Telescopic Tubing				Chuck Wrench		
	Connected Rear Tool Block				Push Button				Countershaft Wrench		
	Controller and Handle				Relieving Att.				Draw In Chuck Wrench		
	Countershaft				Relieving Att. Cams				Length Stop Wrench		
	Countershaft Dog				Relieving Att. Gears				Relieving Att. Wrenches		
	Countershaft Eye				Resistance Box				Spindle Nut Wrench		
	Countershaft Hook				Reverse Plate	1	1	✓	Spindle Spanner Wrench	1	1
	Crankshaft Attachment				Reverse Plate Cover	1	1	✓	Tail Stock Wrench	1	1
✓	Cross Feed Handle	1	1		Reverse Pulley			✓	Tool Post Wrench	1	1
	Diameter Stops				Right Hand Tail Stock Screw				Double end wrench	1	1
	Floor Pan				Round Tool Post	1	1				
	Follow Rest				Screws for Motor						
	Four Way Tool Block				Shafting Rest						
	Full Swing Rest				Shear Wipers	1	1				
	Gear Plate and Cover				Sightfeed Oilers						
	Grease Cups				Small Face Plate	1	1				
	Guide Rest				Sprocket Chain						
	High Duty Tool Block				Sprocket Wheel and Pins						

Please do not destroy packing material until all articles and parts indicated have been found. All claims for shortage should be accompanied by this list.

PACKED BY C. Keller DATE April 4, 1924 INSPECTED BY A. Boschert

Fig. 12. Packing List which is checked by the Packer and the Final Inspector

34. The rack is inspected to see that it is polished, that the fillister-head screws by means of which it is attached to the bed are inserted to the proper depth, that the correct number of dowel-pins are used in the rack, and that they are driven to the proper depth.

35. The lead-screw index-plate *K*, Fig. 9, is inspected to make sure that it is the proper one for the lead-screw used.

36. The back-gear and face gear are inspected, and the back-gear shifter lever tried out. The gears must not strike covers and must run smoothly and quietly.

The final inspection card shown in Fig. 8 is made out by the inspector on the testing floor. When any particular unit of the lathe does not pass inspection, the foreman of the department in which the unit was assembled is called to

the testing department to correct the trouble. The final inspection card is then sent to the works office for permanent filing. When the lathe has passed inspection, it is sent to the shipping floor, where all parts and attachments called for on the order are checked on the packing list illustrated in Fig. 12. This serves as a double check, the first being made by the packer and the second by the final inspector. A copy of this packing list is sent with the lathe to the customer, and another is filed in the sales office.

From the foregoing information it will be apparent that considerable care and attention are necessary in the inspection of lathes. From the moment that the raw stock is received up to the time that the lathe is put on skids for shipping, practically every step is inspected.

* * *

STANDARDIZATION OF T-SLOTS

A committee under the auspices of the American Society of Mechanical Engineers and the National Machine Tool Builders' Association, organized under the procedure of the American Engineering Standards Committee, is now at work in an endeavor to determine upon suitable standards for T-slots for machine tools. The study of the subject so far made has brought out the following facts:

Commercial T-slot cutters, such as are now on the market and which seem to be standard American practice, are practically uniform. Comparison has been made of such cutters listed by thirteen manufacturers, all of which show the same proportions. English practice appears to vary somewhat from American, in that the heads of T-bolts are thicker, thus requiring the wide part of the T-slot to be deeper. The maximum depth of the throat of the T-slot is also greater in British practice, so that if the slots are milled with T-slot cutters, a longer neck than provided in American practice would be required. A study of other foreign practices shows that one system is in use in Sweden that is as nearly identical with some of the present American T-slot systems as it can be made, when translating into even metric dimensions. German and French standards appear to vary in several respects from American practice.

Among the thirty-eight American firms whose practice has been recorded through the investigation of the Marvin & Casler Co., Canastota, N. Y., twenty use T-slots that can be milled with the cutters referred to, which may be considered as standard American T-slot cutters.

Use of T-bolts and T-nuts

Two distinct lines of practice have been developed, one in which a T-bolt is used in the T-slot, and the other in which a nut is used in the T-slot with an ordinary screw or bolt threaded into it. Under the first plan there are two types: (a) where the bolt and T-slot are nominally of the same size (in the Brown & Sharpe practice, for example, the bolt is turned down throughout the length of its body to the size used for the tops of the threads; in the case of the quarter-inch bolt this is 0.016 inch less in diameter than the width of the slot, while for a one-inch bolt it is 0.028 inch less); (b) where the T-bolt is of appreciably smaller size (generally 1/16 inch smaller for the smaller sizes, and ⅛ inch smaller for the larger sizes); this permits clearance between the bolt and the T-slot.

Under the second plan—that of using a nut in the T-slot—the bolt is always made smaller than the T-slot in order to allow stock on each side of the tapped hole in the tongued portion of the T-nut. An advantage claimed for this method is that it is cheaper to produce T-nuts of this type than to forge and finish bolts.

Plans Possible for Standardization that will Retain Standard Cutters

Three plans for standardizing T-slots are possible without a change from the well established line of cutters now available. These plans are (1) making the narrow part of the slot, or throat, the same as the nominal diameter of the bolt; (2) widening the throat of the T-slot so as to be 1/16 to ⅛ inch wider than the diameter of the bolt, and retaining the same dimensions of the T-slot otherwise as for the bolt used in Case 1; (3) using a size larger cutter for producing the T-slot, and providing a line of bolts with larger heads in proportion to the diameter to fit into these enlarged slots.

In order to obtain standards that will meet the needs and in part, at least, take care of present as well as future designs, Plans (1) and (2) can be combined, and the choice be left to the designer. In this method the same T-slot cutter will be used in either case, when a given size of bolt or screw is to be used, the only difference being that the throat of the T-slot would be planed wider under Plan (2) than under plan (1). If such a plan were adopted, fixtures and tools would be made interchangeable between machines made to these two systems, by using reversible tongues, which already constitutes a well established practice. Several leading machine tool builders now have many thousands of attachments in the hands of users provided with reversible tongues, so that they can be used for either one of two widths of slots.

If the plan mentioned were adopted, it may be considered either as a permanent feature of standardization, or it may be considered as a transition method and used until such time as one or the other of the two plans becomes practically universal. An estimate has been made of the number of slots of different sizes that are used in machine tools. The sizes that predominate in machines built by the Brown & Sharpe Mfg. Co., are as follows: 12 per cent use ¼-inch slots; 12 per cent, 5/16 inch; 14 per cent, ⅜ inch; 8 per cent, 7/16 inch; 24 per cent, ½ inch; 15 per cent, ⅝ inch; 8 per cent, ¾ inch; and 6 per cent, ⅞ inch. In regard to limits for T-slots, it may be said that generally speaking, the T-slots are finished 0.001 inch small, and the tongues are made 0.001 inch large, the final fitting being done after all other operations are completed. This fitting produces either a tight sliding fit, or in the case of many fixtures, a fit that requires a slight pressure to assemble and take apart.

* * *

MEETING OF THE SOCIETY OF AUTOMOTIVE ENGINEERS

The spring meeting of the Society of Automotive Engineers was held at Spring Lake, N. J., June 24 to 27. The meeting was attended by a large number of members and guests, and during the four-day meeting, there were sessions devoted to new designs of transmissions, standardization, crank-case oil contamination, air-cleaners, and riding qualities of cars.

The new forms of transmissions were dealt with by Professor J. M. Nickelsen of the University of Michigan, who described European and American developments and analyzed the possibility of doing away with transmissions altogether. An engineer of the Weiss Engineering Association described an unusual form of universal speed transmission and demonstrated a car fitted with it. The complete papers read before the convention may be obtained from the society's headquarters, 29 W. 39th St., New York.

* * *

The Board of Trade for German-American Commerce, Inc., has been organized for the purpose of re-establishing and furthering commercial relations between the United States and Germany. The association will be the central body for the exchange of information on all matters pertaining to trade, industry, and finance; for the widening of existing and the opening of new markets; for aid in facilitating customs and tariff matters; for arbitration of commercial disputes; and for rendering assistance in all questions which tend to promote and widen friendly commercial relations between the two countries. The address of the Board of Trade for German-American Commerce, Inc., is 60 Broadway, Suite 507, New York City.

ECONOMIZER

An apparatus designed to save waste flue-gas heat in power plants is called an *economizer* and consists of a bank of tubes through which the water passes on its way to the boiler. The economizer is usually placed behind a row of boilers and a little above them.

ATMOSPHERIC PRESSURE

The normal atmospheric pressure at sea level is generally assumed to be 14.7 pounds per square inch, which corresponds to 29.92 inches of mercury. Frequently, however, the atmospheric pressure is assumed to be the pressure of a 30-inch vertical column of mercury at 32 degrees F., which corresponds to 14.73 pounds per square inch. In the countries using the metric system, the pressure of an atmosphere equals 760 millimeters of mercury (29.92 inches) at 32 degrees F. This corresponds exactly with a pressure of 14.7 pounds per square inch, and is the value generally used in engineering calculations. The pressure in atmospheres is frequently used as a measure for air, steam, or liquid pressures. For example, a pressure of five atmospheres would equal $5 \times 14.7 = 73.5$ pounds per square inch. In calculations where extreme accuracy is not required, it is often assumed that an atmosphere equals 15 pounds per square inch. This makes it easier to perform calculations, five atmospheres being then equal to 75 pounds per square inch.

BLANCHED COPPER

Blanched copper is an alloy of copper and arsenic, containing 91 per cent of copper and 9 per cent of arsenic. It is used for clock-dials and for the scales attached to thermometers and barometers. The alloy is made by heating copper strips or chips with white arsenic in an earthenware crucible. The copper and arsenic are laid in alternate layers in the crucible, and the top is covered with common salt.

STEAM TURBINE OPERATING PRINCIPLE

A steam turbine is a prime mover in which steam at high velocity impinges upon the blades of a rotating element, thus transforming the kinetic energy of the steam into mechanical energy. The steam turbine, unlike the reciprocating engine, makes use of the *velocity* of the steam instead of its static pressure. The heat energy of the steam is, through expansion, first changed into kinetic energy, and this in turn is transformed into work by the impulse and reaction effects produced by steam jets discharged through suitable nozzles against vanes upon the periphery of a revolving wheel. In both cases, the work done is due to the heat energy contained in the steam. In the reciprocating engine, the action is intermittent, while in the turbine, it is continuous. The steam turbine is especially adapted to central station work for the following reasons: It has a high speed, with close regulation; it gives high economy under variable loads; it works under conditions of practically a diabatic expansion of steam, the ideal condition sought for in the design of all steam engines; it eliminates cylinder condensation, because the passages through which the steam flows are always at practically the same temperature; it has no reciprocating parts, with rubbing surfaces to be lubricated; it produces no vibration which calls for expensive foundations; and finally, the floor space required is much less than for a reciprocating engine of the same power.

SELECTIVE ASSEMBLY

Selective assembly refers to a method of manufacturing in which component parts are sorted and mated according to size and assembled or interchanged with little or no machining. Companion parts made to the extreme limits are not supposed to interchange. For instance, a shaft or pin of maximum size will not assemble with a mating part of minimum size. A good example of this method of assembling is found in the production of ball bearings. The balls are sorted into groups, according to their size, to facilitate the assembly of any bearing with balls of uniform size. Nearly every so-called "interchangeable" article represents a combination of interchangeable and selective methods of quantity production.

ELECTRO-ETCHING

The process of etching may be performed by the use of electricity. When the wires leading from the poles of an electric battery are placed in a solution of copper sulphate, and a copper plate is attached to the positive wire, the object to be plated being attached to the negative, an electroplating outfit is formed. The deposition of a metal will not take place on any substance but a metallic one, and it is this fact which makes it possible to employ electricity in etching. When the battery is in action, the copper is taken from the anode, or article attached to the positive wire, and deposited on the cathode or article attached to the negative wire. First let it be assumed that a piece of sheet copper is used as a cathode. In the ordinary course of procedure, the copper from the anode, when properly regulated, will be removed and deposited in a fairly even surface on the cathode. Now suppose that a design is painted on the anode like the letter A with wax, varnish, or any substance that will not be affected by the solution. When the current is flowing, the copper will be removed only from the exposed surface of the anode; the protected surface will not be affected. In consequence, it will be found that after a time the design will stand out in relief. This illustrates the principle, but the method may be varied; for instance, the background may be coated instead of the design, in which case the figure will be etched and the ground will stand out. Also, the operation may be performed on the cathode instead of on the anode, in which case the exposed parts are built up. The variations possible in using this process may be shown by the following example: Expose the letter A on an anode of copper or gold. The result will be that the letter will appear in relief. It should then be carefully rinsed in clean water without disturbing the ground. Suppose, for instance, that gold is used and it is exposed on the cathode in a silver bath, the silver being deposited in place of the gold that has been removed. Removing the piece from the bath and cleaning, the letter A is found designed in silver on a background of gold. This method is, of course, applicable to any combination of metals.

CHECKING OF STEEL

The cracking or checking which sometimes occurs when grinding high-speed steel tools is said to be caused invariably by the use of cooling water while rough-grinding the tool. A practice recommended is as follows: Have the tool rough-forged to approximately the required shape; grind the tool slowly at first until it becomes warmed through, after which the grinding may be done rapidly without injury to the tool, but water should not be used when rough-grinding, as it tends to cause checking.

STONE-SAWING STRAND

For sawing blocks of sandstone, limestone, or similar soft stone, a wire strand made by twisting three wires together is used. The sand-sawing strands should not be used for sawing marble or granite, as they are not suitable for these harder stones. The strands are made in five different sizes, varying from 1/8 to about 7/32 inch in diameter, the approximate gage of the wires used varying from No. 16 to No. 12 steel wire gage.

TURRET LATHE SIZES

There are two general methods of designating the sizes of turret lathes. If the machine is intended primarily for operating on bar stock which is fed through the spindle, the size of the machine, as listed by manufacturers, indicates approximately, at least, the maximum diameter of stock that will pass through the spindle, and the maximum length that can be turned. For instance, a 2- by 24-inch turret lathe has a maximum capacity for parts 2 inches in diameter and 24 inches long. In some cases, however, the nominal size of the machine is somewhat less than the actual capacity; thus, a turret lathe listed as a 2-inch size may, in reality, be capable of handling bar stock up to 2¼ inches in diameter. The size of a turret lathe intended more especially for chucking operations indicates the maximum diameter that the machine will swing over the ways of the bed; that is, a 24-inch chucking machine is one that will swing parts up to about 24 inches in diameter.

CORONA LOSS

When the voltage of an overhead transmission system or of conductors in general exceeds a certain critical value, depending upon the spacing and diameter of the wires, there will appear on the surface of the conductors a halo-like glow to which the name "corona" has been given. Apart from this luminous effect, the appearance of the corona is accompanied by a certain loss of power, proportional to the frequency and the square of the amount by which the pressure between the conductors exceeds a certain value known as the "disruptive critical voltage." The action of corona on insulation manifests itself chemically, mechanically, or by heat. At high altitudes particularly it is not advisable to use the smaller sizes of wire because of the corona loss, or the loss due to the breaking down of the air insulation.

TITANIUM STEEL

Titanium is one of the elements that have been employed with marked success to improve the quality of steel. It has also been very successfully used for cast iron and for some of the non-ferrous metals. The first heat of titanium steel made in America was poured in 1907, and since that time a great deal of investigation has been conducted and many experiments have been made. These tests have shown that, when ferrotitanium has been added to steel or iron in very small quantities, it has greatly strengthened these metals and improved their qualities in other ways; it is one of the best of the purifying elements that have been used in the manufacture of steel. Titanium is one of the metallic chemical elements, the symbol of which is Ti, and the atomic weight, 48.1. Titanium has a brilliant white fracture and is harder than steel. Its specific gravity varies from 4.5 to 4.9. It melts at a temperature of 1900 degrees C. (3452 degrees F.). Its specific heat is 0.112. Titanium is most commonly found associated with iron in various iron ores.

POUNDAL

The expression "poundal" is sometimes used in connection with calculations in mechanics. Many mechanical handbooks, however, do not define it, because of its limited use. A poundal is a unit of force, and is defined as that force which, acting on a mass of one pound for one second, produces a velocity of one foot per second. A foot-poundal is a unit of energy equal to the energy resulting when a force of one poundal acts through a distance of one foot. In order to reduce foot-poundals to foot-pounds, multiply the number of foot-poundals by 0.03108. Dividing the number of foot-poundals by 32.16 (acceleration due to gravity) will also give foot-pounds.

BISMUTH BRONZE

Bismuth bronze is an alloy containing 69 per cent of copper, 21 per cent of zinc, 9 per cent of nickel, and 1 per cent of bismuth, with traces of tin. This alloy may be considered as a low-grade German silver.

BLANCHARD LATHE

The Blanchard type of lathe is named after the inventor, Thomas Blanchard, who built the first lathe of this kind in 1822. This machine is designed especially for turning wooden parts of irregular shape, and has been extensively used for turning the stocks of guns and rifles. There is a former or model which corresponds to the shape required. The former is mounted on one side of an oscillating frame which carries on the opposite side the wooden blank to be turned. The former and the blank are rotated at the same speed by gearing, and the turning is done by a rapidly revolving cutter. The cutter is mounted on a carriage and traverses along the bed; at the same time, a wheel which bears against the former or model to be reproduced also moves along with the carriage, and the contact of the model with this wheel causes the frame that supports the work to oscillate in such a way that an accurate copy of the model is turned by the revolving cutter.

GAS ABSORPTION BY LIQUIDS

Many liquids have a capacity for absorbing a certain amount of gas. The quantity thus absorbed varies with the liquid and the gas. Many gases, for example, are readily absorbed by water; thus, water will absorb its own volume of carbonic-acid gas, over two times its volume of chlorine, and 430 times its volume of ammonia. Water will not, however, absorb more than 5 per cent of its volume of oxygen. The weight of gas that a given volume of liquid will absorb is proportionate to the pressure, but as the volume of a given mass of gas is proportionately less as the pressure increases, the volume which a given amount of liquid will absorb at a certain temperature is constant, whatever the pressure. Water absorbs its own volume of carbonic-acid gas at atmospheric pressure. If the pressure is doubled on both the gas and water, the latter will still absorb its own volume of the gas under the higher pressure, but, in that case, the density of the gas is doubled and, consequently, double the weight of the gas is dissolved. The quantity of gas absorbed increases as the temperature is lowered. One of the most important instances of the absorption of gases by liquids is met with in the absorption of acetylene by acetone; the latter liquid absorbs, at 60 degrees F. and 180 pounds pressure per square inch, 300 volumes of acetylene gas. This property of acetone makes it possible to safely store and transport acetylene gas in steel containers.

A Combination Type of Metal-cutting Machine

Universal Machine Especially Adapted for Reproducing Various Designs from Enlarged Patterns or Drawings, Either by Punching, Profiling, Routing, Milling, or Engraving

By S. A. ASQUITH

IN experimental or development work, it is necessary frequently to make parts from sheet metal, but the number of pieces required at first is not large enough to warrant the use of expensive dies, particularly if changes are likely to be required as the result of experiments. In certain other branches of metal-working, expensive tool equipment which is limited to the production of duplicate parts can never be employed to advantage. The machine to be described has been designed to meet the requirements of cases of the class mentioned, as it is capable of performing a great variety of operations and can be arranged for different classes of work merely by making a few adjustments and providing an inexpensive pattern or drawing of the part to be reproduced. The particular machine illustrated (see Figs. 1, 2, and 3) is only a preliminary model, which is to be superseded by a design representing better construction. This model, however, embodies the important elements, as well as the fundamental operating principles.

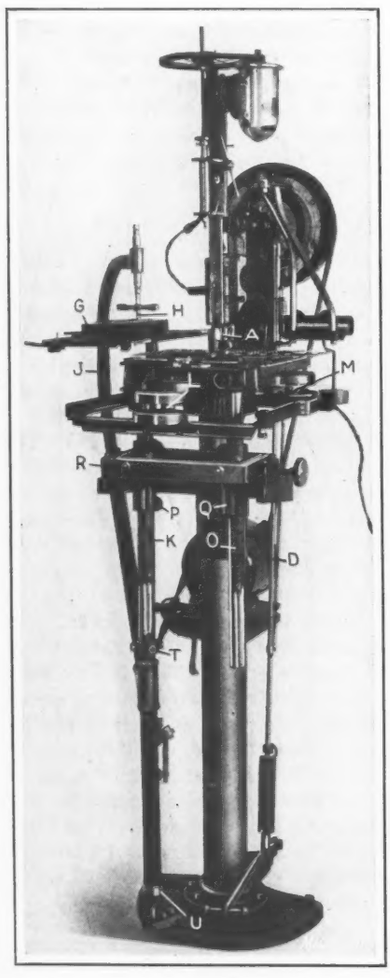


Fig. 1. Universal Metal-cutting Machine

This metal-cutting machine, which is universal to an unusual degree, is used chiefly for cutting, from sheet-metal stock, various shapes or designs which are reproduced either from an enlarged pattern or directly from a drawing. For work of this general class, the part or design is cut out by a rapidly reciprocating punch, while the sheet of metal, held in a suitable work-holder, is mechanically guided along a path conforming to the outline of the drawing or templet. The movement of the work is controlled by a pantographic mechanism, which is adjusted to give the required scale of reduction. Provision is made for using a rotating milling or routing cutter, instead of a punch for milling irregular die impressions, engraving radio panels, or similar work. A third attachment on the machine provides a non-rotating engraving tool as the cutting element for engraving designs, letters, etc., on copper plates, and various other surfaces.

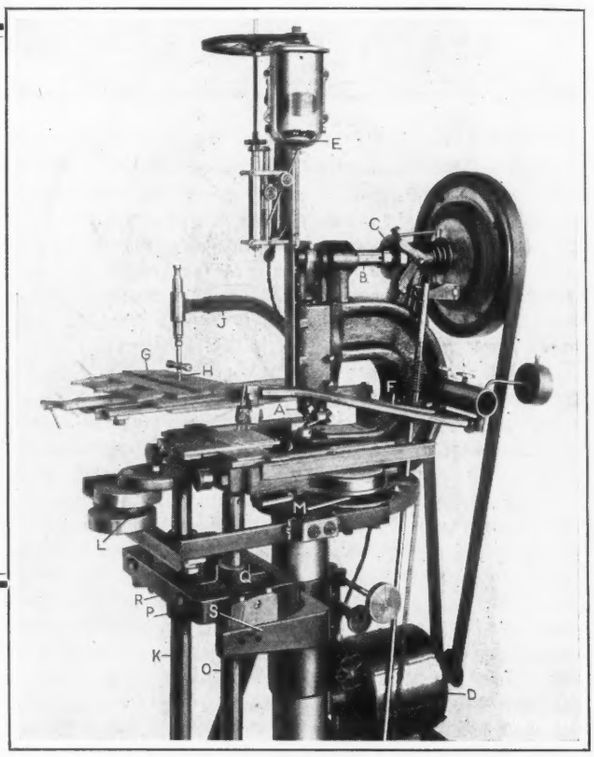


Fig. 2. Engraving Attachment in Operating Position

This machine will produce from sheet metal such parts as stencils, emblems, monograms, or other artistic designs, small spur gears or internal gears, racks, templets, etc. In fact, practically any part can be produced that can be cut from sheet metal having a thickness of ⅛ inch or less. The pattern, which may be from two to ten times as large as the finished part, may be made of any material such as tin, pasteboard, or wood. The machine can also be used for making its own metal pattern directly from a drawing, or the drawing can be employed without a pattern, whenever this seems to be advisable. The making of small blanking punches and dies, especially in connection with experimental work, can be done readily by means of the milling attachment (referred to later), and the production of experimental cams and profile gages represents other examples of work. The important elements of this machine and its general method of operation will now be considered.

Mechanism for Operating Cutting Tools

In cutting parts from sheet metal on this machine, the outline is formed by a punch operating in conjunction with a mating die and arranged to reciprocate so rapidly that it leaves smooth edges, since the feeding movement of the work is relatively slow. The punch is attached to a vertical slide *A* (see Figs. 1 and 2) which receives its motion from an eccentric on the main shaft *B* (Fig. 2). The starting and stopping of the punch is controlled through a clutch in the flywheel, which connects with a foot-treadle located at the base of the machine. The driving member of the

clutch is connected with motor *D* by a belt, as shown. The work on which the punch operates is fixed to a work-holder, which is mechanically guided along the path desired by means of a mechanism to be described later.

Although the rapidly reciprocating punch is used for cutting various forms from sheet metals, certain operations, such, for example, as the milling of blanking dies or of punches to fit them are performed by means of the milling attachment. When this attachment is not in use, it is located at the upper part of its slide as in Figs. 1 and 2; but when milling a die or other part, it is lowered to the operating position, as shown in Fig. 3. The vertical spindle of this attachment is driven independently by a separate motor *E* through a belt drive.

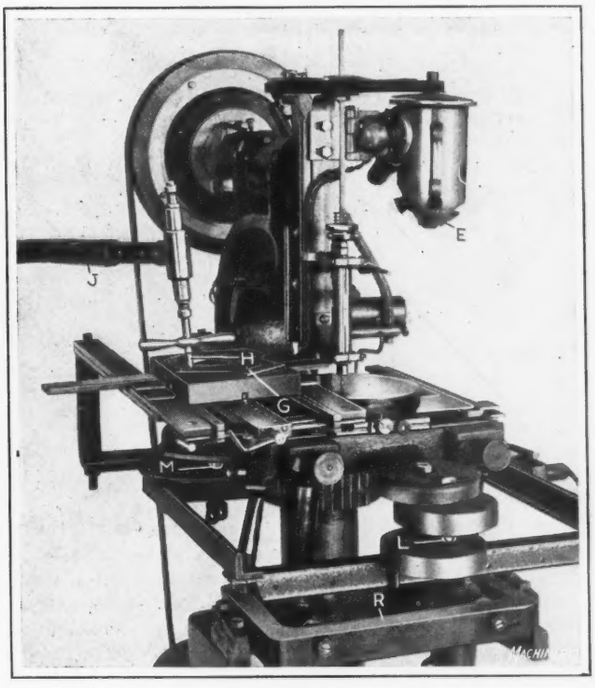


Fig. 3. Milling Attachment in Use

The engraving attachment consists of an arm *F* (Fig. 2) which is hinged at the rear of the machine so that it may readily be placed in the operating position, as shown, or up out of the way, as represented in Figs. 1 and 3. The engraving is done by a fixed or non-rotating cutter, and the work is mechanically guided in the same manner as in the milling or punching operations.

Pantographic Mechanism

When this machine is in use, an enlarged pattern or drawing is attached, as at *G*, to a fixed table which is located just above the work-holder, so that both the work and pattern may be seen readily. The operator moves a tracer point *H* attached to the curved arm *J*, along the edge of the pattern or drawing outline. This motion of the curved arm is transmitted to the tracer arm *K*, the upper end of which connects with the work-holder. The latter, which is free to move horizontally in any direction, is mounted on three balls, thus reducing frictional resistance as far as possible. One ball supports the front end of the work-table at *L*, another is at *M*, and a third in a location corresponding to *M* but on the opposite side. The tracer arm *K* is attached to the work-holder by a ball and socket connection. Another arm *O*, parallel to *K*, also has a ball and socket connection and serves to prevent any swinging movement of the work-holder about the axis of tracer arm *K*. Both of these arms, *K* and *O*, are free to slide through their bearings (*P* and *Q*), which are pivoted or trunnioned in the sides of frame *R*. This frame is also pivoted at its ends with bracket *S* (Fig. 2), which is held by the main column of the machine and adjustable vertically on this column.

This double trunnion arrangement allows arms *K* and *O* to swing in any direction, and as there are ball and socket joints at *T* and *U* (see Fig. 1), any motion of the tracer point *H* along the pattern is freely transmitted to the work-holder, but on a smaller scale, according to the adjustment. Inasmuch as this work-holder always moves in the same horizontal plane, it is evident that changes in the angularity of tracer arm *K* will result in corresponding changes in the distance between the ball and socket connections at the upper and lower ends of *K*. To permit of these changes in length, there is a telescopic connection between the lower ball at *T* and the tracer arm.

Adjustment of Mechanism for a Given Reduction

In cutting out a design or part from sheet metal, the pattern or drawing is usually much larger than the work, thus insuring a corresponding reduction of any errors in the pattern. The amount of reduction depends upon the position of the pivoted frame *R*, the supporting bracket *S* being adjusted along the main column for different reductions. In order to understand how the desired scale of reduction is obtained, it should be remembered that the distance between the ball and socket joints *T* and *U* (Fig. 1) is fixed, as well as the distance between connection *T* and the surface of the pattern table. Assume, for example, that the relation between these dimensions is in the ratio of 3 to 1.

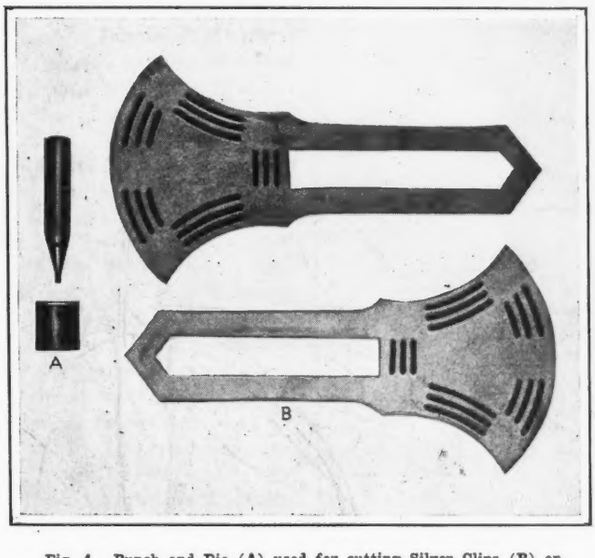


Fig. 4. Punch and Die (A) used for cutting Silver Clips (B) on Machine shown in Fig. 1

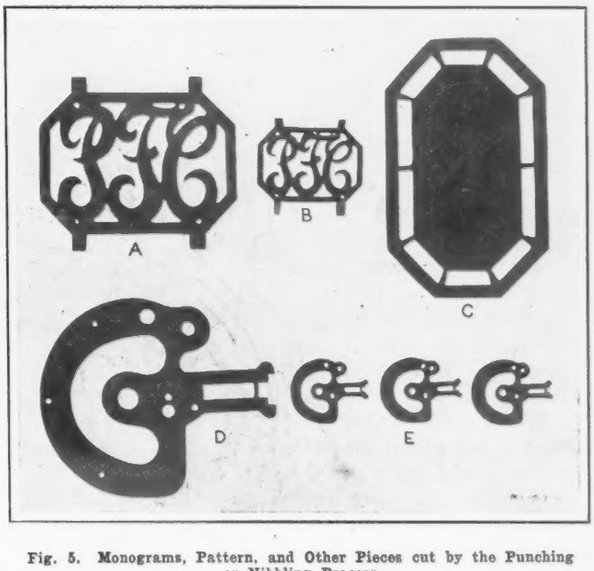


Fig. 5. Monograms, Pattern, and Other Pieces cut by the Punching or Nibbling Process

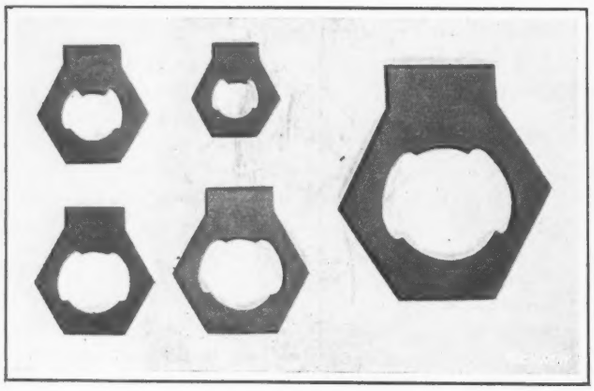


Fig. 6. Sample Lock-washer cut out by Punching Process

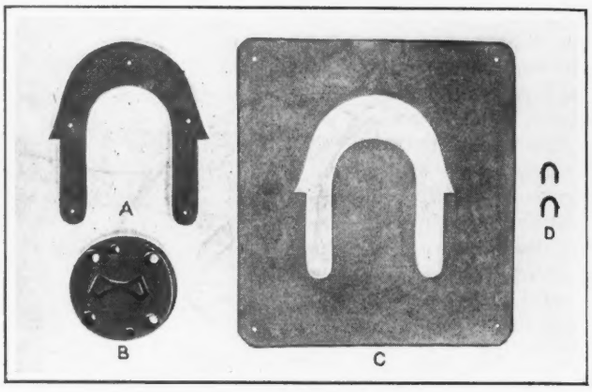


Fig. 7. Patterns for milling Punch and Die, and Example of Die Work

Then, if the pivots of frame *R* are located midway between joint *T* and the work-holder, the scale of reduction will be 3 to 1. If frame *R* is elevated so that the work-holder travels in the ratio of 1 to 4, as compared with connection *T*, then the actual scale of reduction will be 12 to 1.

The tracer point *H* used with the pattern is a small cylindrical pin, and the relation between the diameter of this pin and that of the punch (assuming that the punching machine is being used) should be the same as the scale of reduction between the pattern and the work. For example, if the pattern is five times the size required for the work, then the tracer pin diameter should be five times larger than the punch diameter. If a comparatively large quantity of blanks is required from a single pattern, a special attachment may be used for guiding the tracer pin mechanically along a pattern of special form.

The type of punch and die used for cutting designs or parts from sheet metal is shown at *A* in Fig. 4. This particular punch is 0.025 inch in diameter, and it has been used for cutting various designs, letters, emblems, etc., but is still in good condition.

Examples of Work

A number of examples of work done on this universal machine are illustrated in Figs. 4 to 8, inclusive. These examples indicate, to some extent, the range of this machine, or the variety of parts that it is capable of producing. The parts at *B*, Fig. 4, are sterling silver napkin clips. These were reproduced from an enlarged tin pattern and cut at the rate of 4 minutes each. The clips illustrated are just as the punch left them; the upper side of one clip is shown and the lower side of the other, both sides being practically the same owing to the absence of burrs.

Fig. 5 shows copper monograms at *A* and *B*, a cuff button pattern at *C*, and parts of a golfometer at *D* and *E*. The cuff button pattern was reproduced from a paper pattern. The holes in the part *D* were punched to their proper size, but the small holes in parts *E* were drilled, as the diameter is only 0.016 inch. Fig. 6 shows some sample lock-washers which were made for an inventor at the cost of 10 cents each. The largest size shown was cut in 40 seconds, the material being cold-rolled steel 0.095 inch thick. The patterns used for milling a punch and die are shown in Fig. 7, at *A* and *C*, respectively. This punch and die is used for blanking out the gold pieces shown at *D*, which illustrate the size of the work. An example of die milling is also included in Fig. 7 at *B*. No hand work whatever has been done on this die.

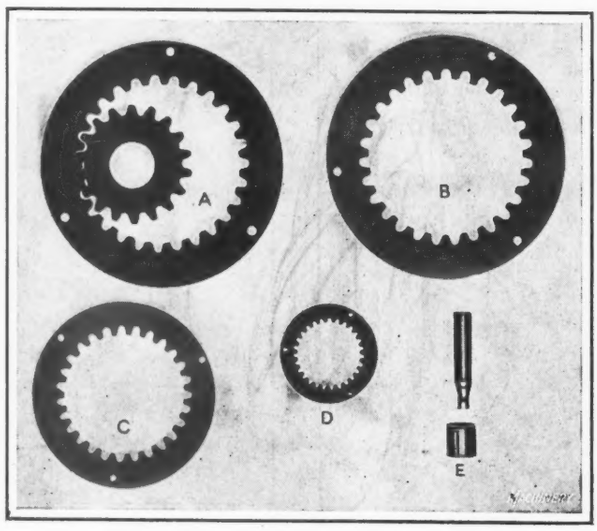


Fig. 8. Gears and Punch and Die (E) used in cutting Them

Some examples of gear work are shown in Fig. 8. These gears are just as they left the punch, the punching member of the machine being used for all work of this kind. The pattern used, is, of course, in the form of a gear, but the pantographic mechanism makes it possible to obtain a variety of sizes and pitches from a comparatively small number of patterns, as indicated by the fact that a gear of 2 inches diameter and 8 pitch, for example, is equivalent to a 1-inch gear of 16 pitch, enlarged twice. By noting the engagement between the fiber gear and pinion at *A*, it will be seen that fairly accurate tooth contours are produced. The reduction in this case from the pattern size, was in the ratio of 2¼ to 1, which, of course, is not as good as a 4 or a 6 to 1 reduction for work of this kind.

The three sizes of internal gears shown were all cut from the same pattern, the cutting time for the large sizes being less than 1 minute per gear. Gear *A* is of fiber, gears *B* and *C* of steel, and *D* of copper. The punch and die used for cutting the large internal gears *A* and *B* is illustrated at *E*.

It will be evident from the foregoing description, that this machine is capable of handling an unusual variety of work, and that the few examples included in this article indicate only in a general way the possibilities of such a machine, especially for experimental and development work.

* * *

Comparison has recently been made between the relative economy in oil well drilling resulting from the use of electric power and steam power. Two companies in California started work on the same day drilling oil wells, one using electric power, and the other steam power. In spite of lost time at the start, due to a crew inexperienced with electric drive, the electrically drilled well was completed on the same date as the steam drilled well; and the power cost in the use of the electrical equipment averaged somewhat less than $16 a day, while the power cost for the steam drilled well was about $100 a day. The cost of the installation of the power equipment for the two wells was practically the same. A further point in favor of the electrical power equipment is that its value after use is estimated at about 90 per cent of the full value, which is considerably more than the salvage value of the steam equipment.

Design of Magazine Attachments

Magazine Attachments for Irregular Work

By ALBERT A. DOWD

THE magazine attachment in any automatic machine must, first of all, deliver the work, even if it should be of irregular form, in a uniform manner. Some pieces are much more difficult to handle than others; for example, the bevel gear forging *A*, Fig. 1, is larger and therefore much heavier at one end than at the other. Also, as it is a forged piece, it may have fins, seams, or other small projections which will interfere with smooth movement. Obviously, a straight-guide magazine cannot be used for this piece, assuming that it is to be machined on centers or in a chuck. In any case it must be delivered from the magazine with the same side always in a given position. When irregular pieces are to be handled in a magazine, the greatest care must be used in planning the arrangement, in order to prevent wedging, interlocking, or cramping of any kind. Such conditions may develop from many causes, such as too much or too little clearance in the magazine guides, or a lack of forethought in arranging the pieces. Also, if forgings or castings are made from several dies or patterns, they will likely vary somewhat and cause trouble in feeding.

The first step in designing a magazine for an irregular piece is to look carefully at its general shape, the size of the fillets, and the location of seams, fins, or raised numbers which may prevent a smooth rolling movement. In considering the work shown at *A*, we know that it will undoubtedly have fins longitudinally where the dies part; that fillets will be in evidence at the junction of the head with the stem; and that it must be delivered from the magazine in about the position shown. It is often necessary to find the approximate center of gravity of a piece in order to determine whether it will be likely to overbalance if handled in a certain way or in a particular position. Usually this can be determined by laying the work on a straight edge, such as a ruler or scale, or even by balancing it on the finger, and then marking the approximate center of gravity with a piece of chalk.

A sample piece is not always available in the preliminary stages of design, but an approximation can be obtained graphically from a drawing of the piece or from a wooden model which can usually be made in a short time. Even a stiff piece of cardboard cut out with a knife to the desired form can be used in an emergency. When gravity is used entirely for feeding the pieces, the possibilities of friction must not be overlooked, as much trouble is caused by neglecting this important factor, particularly when the pieces are arranged to slide down an inclined plane or when they rub against each other in the magazine. All surfaces which come into contact with the work or on which it slides, should be made narrow in order to reduce friction to a minimum.

In determining the shape of a magazine for a given piece, several sketches should first be made of different schemes, and then a careful examination will usually show which idea is most practical. The use of paper, pasteboard, tin, and wooden models will often lead to an excellent development of an idea, the operation of which, on paper, might be problematical on account of unforeseen conditions. The writer is a strong believer in the advantages of such a procedure for doubtful mechanical operations difficult to visualize. By this means it is possible to determine, without great expense, whether a certain mechanical contrivance will function properly.

One of the most important points in machine design is the elimination of the element of chance in the operation of some unit. A design may look all right on paper and may be mechanically correct, yet when it is built, some unforeseen condition may prevent it from functioning properly without more or less expensive changes in the construction. If the actual operation of a unit could be seen before it is built, many troublesome factors would be eliminated. The designer will do well to experiment with simple inexpensive models whenever there is an element of doubt regarding the working of a mechanism.

Designing a Magazine for a Bevel Gear

Having considered the arrangement of pieces so that they will come to the carrier in the desired position, we have

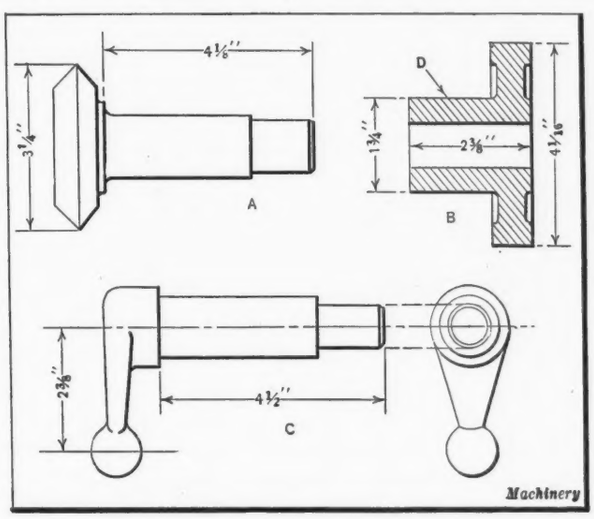


Fig. 1. Examples of Irregular Work for which Feeding Magazines are to be designed

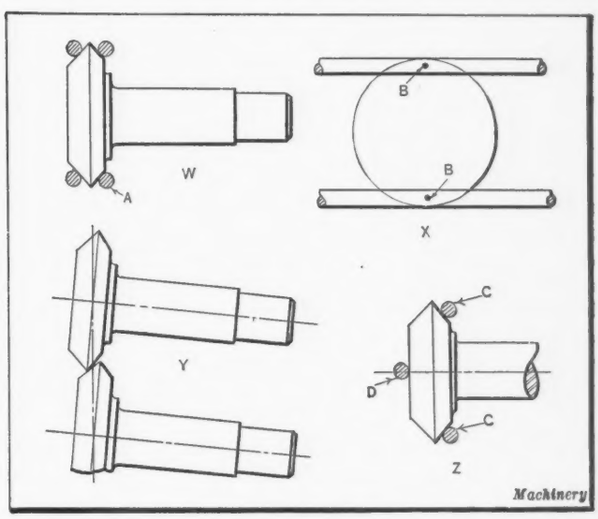


Fig. 2. Diagrams showing Principles involved in designing a Magazine for Bevel Gears

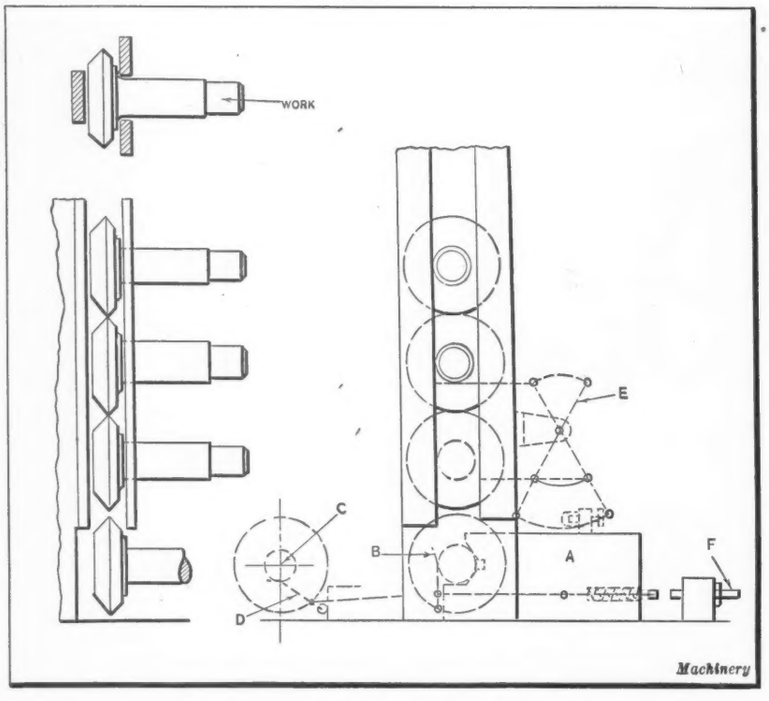


Fig. 3. Preferable Design for the Bevel Gear Magazine

only to decide upon the best design of magazine. Gravity feeds are unsatisfactory for some kinds of work, and it is necessary to resort to mechanical operation. However, this is seldom required in magazines for feeding bar work, forgings, or castings of the sort being dealt with. There are several ways in which forging *A*, Fig. 1, can be fed. For example, Fig. 2 shows at *W* an arrangement consisting of four upright bars *A* arranged in rectangular form between which the angular faces of the forging rest. This scheme appears feasible, but in view *X* it is clear that the work would rock or pivot on points *B* on account of the conical surface of the forging, and that while the pieces would slide down the guides readily enough, they would not "keep their distance," and would doubtless slide as shown in exaggerated form at *Y*. Also, owing to variations in the size of the forgings, a wedging action might take place. If instead of four bars three were used in a construction like that at *Z*, less trouble would be found because the two bars *C* would act as a guide, and bar *D* would keep the work approximately straight. This is an example of three-point construction which is often found useful in mechanical work.

Another magazine is shown in Fig. 3, the plan view clearly showing the general form. An entirely different method is used in this case, as the work is guided by the stem and the large end. In the right-hand elevation the magazine is shown emptying a piece into carrier *A* in which it is clamped by spring *B* and carried over to the centers at *C* on which it is to be turned. The clamp is withdrawn, as shown at *D*, after the chucking. In this magazine the upper pieces are held back by the shutter mechanism *E*. An adjustable stop for the carrier is provided at *F*.

There are now three forms of magazine from which to choose—those at *W* and *Z* in Fig. 2 and that in Fig. 3. Fault has already been found with the design shown at *W*, Fig. 2, and although that at *Z* appears much better, a little thought makes it evident that with this arrangement there could easily be considerable "wobble" at the end of the stems. Such a condition might be overcome by making guide *D* flexible, but this would not be desirable, as considerable friction would result, thus preventing free feeding.

The best solution of the problem is the design in Fig. 3, although even here there is a small element of uncertainty, because of the fillet at the point where the stem of the forging joins the head. If there were only a small fillet, there would be no trouble, but a large one might result in wedging and stop the progress of the pieces through the magazine. If designed with sufficient clearance to take care of all possible variations, there would doubtless be no trouble with this design. The general construction of a magazine of this sort needs no particular comment, but it is advisable to make the back plate and one side plate adjustable so that the magazine can be set to suit varying conditions.

Magazine Designed to Suit Two Operations

Example *B*, Fig. 1, is a small bronze casting which is to be fed from a magazine and faced, turned, and bored while held by stem *D*. In another operation, the work is to be held on a plug and gripped on the large finished diameter while the other side is finished and the chucking stem cut off. Assume that a magazine adjustable to suit both operations is highly desirable, as the work is to be done in a special chucking machine and the device used in connection with the turret. The magazine should be set in such a position that at one complete revolution of the turret the chucking device would receive work from the magazine. The turret would then move forward and allow the piece to be gripped by the chuck jaws.

Fig. 4 shows the general arrangement of a suitable magazine for this piece, and its position with respect to the turret. It is loaded from the front of the machine by the operator, who can obviously attend to several machines without

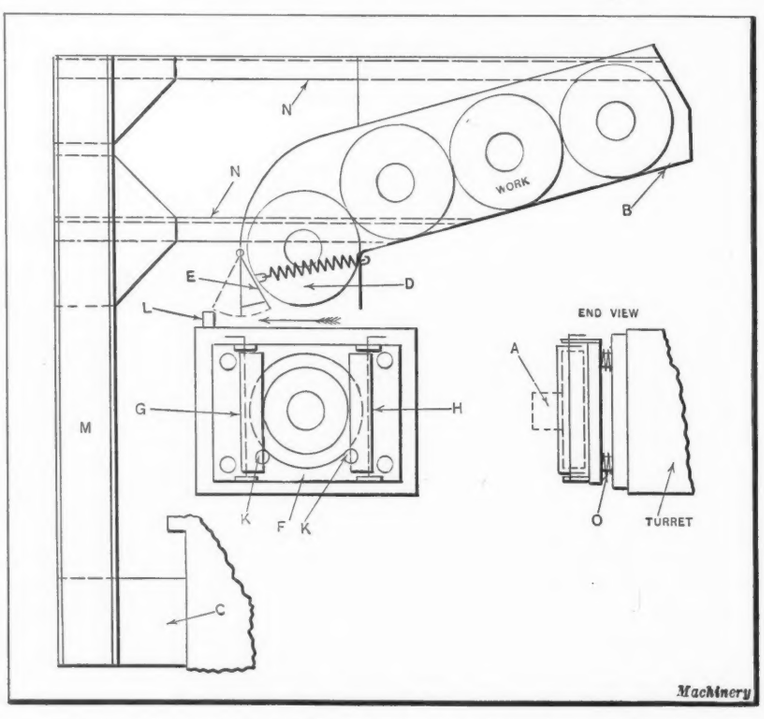


Fig. 4. Magazine for feeding Casting B, Fig. 1, in Two Operations on a Turret Lathe

difficulty. Sufficient details of construction are shown for the designer to understand, but most important of all are the principles involved, as these can frequently be applied to other work of a similar kind. Magazine *B* should be supported in some suitable manner, depending upon the type of machine and the position in which the magazine is held. In this case bracket *C* is fastened to a pad at the back of the machine and on it is mounted a structural steel channel *M*, to the upper part of which angle-irons *N* are fastened. These extend forward and are riveted to the sheet-metal guides of the magazine. It is usually much better to arrange the supporting members at the back of the machine rather than in front for several reasons, one of these being that there is less likelihood of interference with the working parts of the machine, and another, that, when so situated, it is not in the way of the operator.

The magazine chute is constructed of sheet steel, bent to shape, and is slightly inclined to allow the pieces to roll down easily to point *D*, at which position the first piece is supported by the hinged valve *E*. The turret chucking device *F* is fastened to the face of the turret, and has metal guides *G* and *H* at each side. The two locating pins *K* should be made adjustable to take care of variations in the size of the pieces handled. On the upper side of the turret, a trip *L* is located in such a position that when the turret is indexed to the location shown, the trip strikes valve *E* and opens it, as indicated by the dotted lines, thus allowing one piece to fall down into nest *F*. After the piece has dropped, the turret moves forward and carries the work to the chuck, which should be air-operated and have jaws of suitable form to grip the stem ready to machine the part. After the work has been done, the jaws should open automatically, and the piece drop down into the bed of the machine, leaving the chuck ready to receive another piece. Coil springs *O* allow for variations in placing the work in the chuck.

In designing a magazine and carriers of this sort, the designer must follow through the entire process carefully, always keeping in mind that when one piece is removed from the magazine another immediately takes its place, and

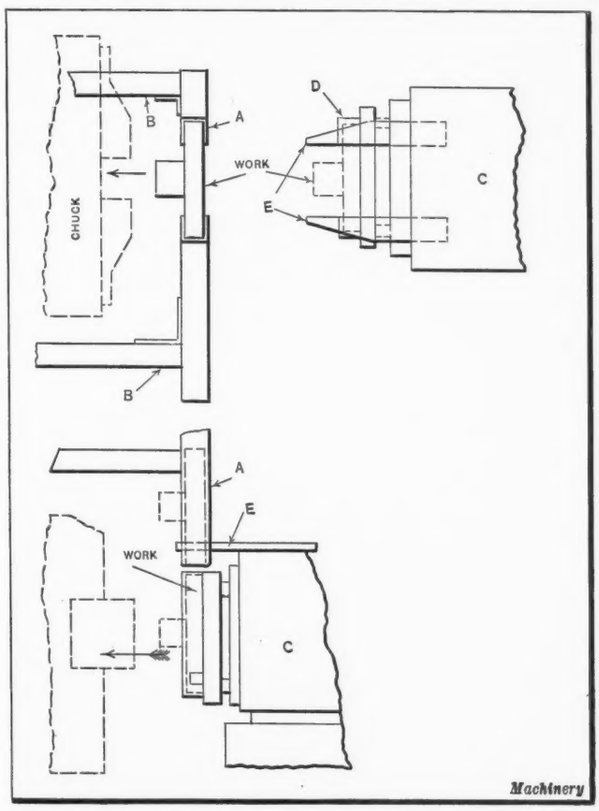


Fig. 5. Another Turret Lathe Magazine placed directly over the Spindle

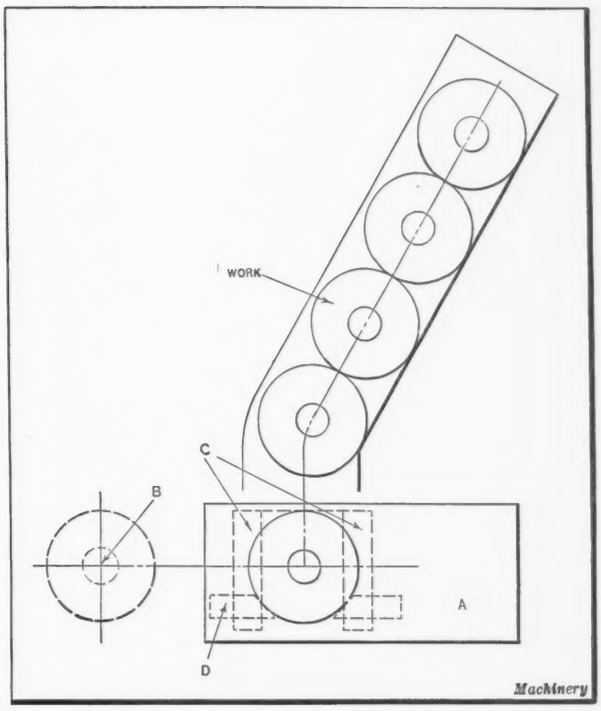


Fig. 6. Magazine designed for Same Part as that in Fig. 5 but for Application to Rear of Machine

so provision must be made to receive it and not permit it to follow the first piece into the carrier. When springs are applied for closing magazine valves, a little experimenting is sometimes necessary to obtain the proper form of spring and one that has the required strength. Also locations of pins on which the work rests may not always be correct, and then the piece will not be properly centered for chucking. Therefore, it is generally better to make such points adjustable so that suitable settings can be made without difficulty.

Other Designs of Magazines for Turret Lathes

Another magazine for placing work of this kind in the chuck is indicated by the diagram Fig. 5. Here the chute *A* is arranged above the spindle, and is supported by brackets *B*. The design of the chute is much the same as in the previous example, but the work comes down and rests against a double valve instead of a single one. Turret *C* comes forward at the proper time with a carrier *D* having projecting fingers *E* above it which open the valve and allow the work to drop into the nest on the turret. A continuation of the turret movement carries the work forward to the chuck jaws. The dotted diagram in the lower part of the illustration shows the position of the work in the carrier after dropping and before chucking. In almost every form of magazine, the carrier or chucking device design is controlled by the shape of the work and the form of the chute. When mounted on the turret and used to push work into a chuck, such a device must be flexibly mounted if the nature of the work requires that it should be pushed back firmly into the chuck jaws. When this is not necessary, the movement can be controlled by the cam that operates the turret.

Another magazine for application to the rear of a machine is shown diagrammatically in Fig. 6. The mounting is similar to those used for bar or other work held on centers. The work lies in the chute with one piece over another, and the lowest one either resting on carrier *A* or in the chucking position *B*. With this arrangement the necessity for a spring valve is obviated, although the carrier must have suitable provision for keeping the pieces vertical, and also spring releasing members *C* which will allow the work to pass into the chuck when pushed by a device on the turret. The carrier is equipped with adjustable work supports *D*.

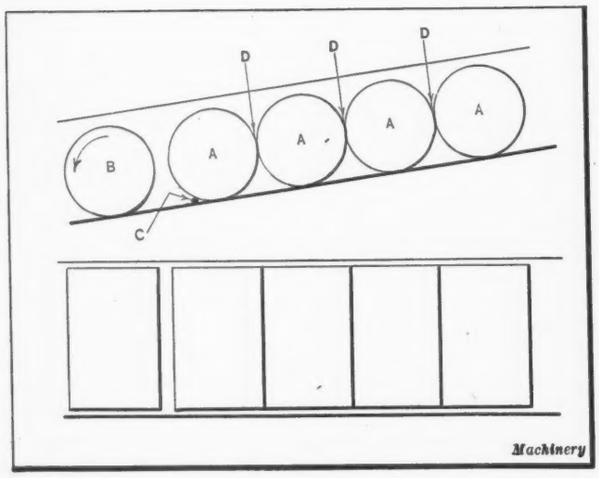


Fig. 7. Diagram illustrating Effect of Friction on the Rolling of Parts in Magazines

The design of any magazine should nearly always be of open construction for several reasons: It is easy to see when the magazine needs refilling; it is not likely to become clogged with dirt; and it is cheaper to make than a closed form. There are cases when the closed form is preferable, but seldom on this kind of work. Sheet metal can be bent without difficulty into various forms and readily riveted or brazed together, which makes it a desirable material from which to construct chutes. The inside surfaces should be kept smooth by using countersunk-head rivets, where necessary, or better still, by designing the magazine in such a way that rivets do not pass through walls where moving parts are carried.

Supports for the magazine should nearly always be made adjustable to provide for variations in castings or forgings. More than one adjustment is often necessary for the size of the work and its relation to the carrier. When a gravity feed is used, it is not always necessary to support the magazine rigidly, but when mechanical feeding devices are applied, the supports must be rigid enough to carry out the operation without undue vibration.

Friction surfaces should be made as small as possible consistent with good design, always bearing in mind that line or point contacts with the work are to be preferred. Pieces that are to roll into position should be fed in a chute having a sufficient incline so that they will roll freely. Care must always be taken with circular pieces having long surfaces that come into contact with each other, as shown in Fig. 7. Pieces *A*, considered one at a time, would roll down a slight incline unless they were badly distorted. However, when in a group, the first one starts to roll and gets away from the others, as shown at *B*, but a grain of sand or small chip in front of one of the others, as at *C*, may prevent it from starting because of the resistance at this point and the friction of the contact at points *D*. Of course, if the angle of the incline is great enough no trouble will be found, but while a 5-degree angle is sufficient to carry a single piece it is advisable to make the incline steep enough to prevent any possibility of sticking.

The importance of a smooth-working positive valve action for releasing pieces from a magazine should be emphasized, for on the correct admission of the pieces to the carrier depends the success of the entire mechanism. Cases are found where springs, rubber bumpers, or sheet rubber "cowls" are necessary at the mouth of the magazine, but such devices are more frequently required in handling work of a different character from that which has been considered.

Piece *C*, Fig. 1, which is to be machined on centers that have previously been drilled, is suitable for machining on the type of machine used for short bars, except for the difficulty in setting it up automatically. Assume that a faceplate driver is used with an air-operated device for driving the work by gripping the ball-end, a floating movement being provided to allow for variations in the distance between the shaft center and the ball. There are several interesting problems connected with designing an attachment for this piece. First, the faceplate must be stopped at a specified position in relation to the work, in order that the arm may enter the holding device properly. It is possible to place some sort of irregular pieces in position to eliminate the necessity of stopping the rotation of the chuck. The writer has made several devices for similar pieces which have been successful, although the pieces were not held on centers, as this is.

The magazine for this work must be different from any of the previous examples, as the pieces are so heavy at the ball end that they cannot be balanced on the cylindrical portion. Therefore a special arrangement of guide rails and guards is necessary, as shown at *A*, Fig. 8, in which the pieces rest on knife-edges *B* with a guard *C* and *D* at each end spaced far enough apart to allow clearance. Another guard *E* prevents the piece from tipping out of position. These pieces cannot be held in a vertical chute because the overhanging ends would strike each other and cause incorrect positioning. However, they can be held in guides at an angle of 45 degrees, as shown at *F*, and while they will not roll they will slide easily down this incline without wedging or cramping.

There is a necessity for a stop arrangement at the lower end of this device similar to a valve, but this can be of trigger form to allow one piece to come through and stop the others, as shown in the enlarged diagram at *H*. There are two sliding cut-off blades *K* and *L*, both of which are controlled by a movement of lever *M* which is attached to a pivoted shaft. To this shaft another lever *O* is connected in such a way that when carrier *G* comes into position for a load, it strikes the end of lever *O* and pulls it over, thus withdrawing blade *L* and letting one piece of work fall into the carrier. At the same time blade *K* is moved up to prevent the next piece from following. When the carrier returns again, spring *R* pulls lever *O* forward returning blade *L* into place and withdrawing blade *K*. There is an adjustable trip *J* on the carrier. Care must always be taken to design shut-off mechanisms with sufficient adjustments so there will be no difficulty in timing up the movement.

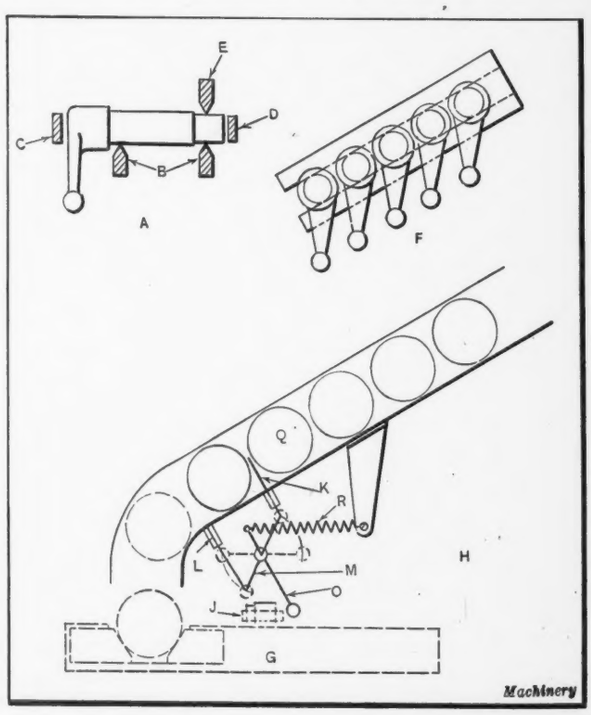


Fig. 8. Design for handling the Topheavy Forging C, Fig. 1

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Swing, Inches			Length of Bed, Feet	Maximum Distance between Centers, Inches	Horsepower of Motor, if Motor-driven	Belt Width, Inches, if Belt-driven†	Range of Feeds per Inch	Range of Threads per Inch	Spindle Speeds, Minimum, Maximum, R.P.M.	Diameter of Hole in Spindle, Inches	Size of Tool, Inches	Net Weight, Pounds
Nominal	Actual over Bed	Actual over Carriage										
9	9½	7¾	2½	8¾	½ to ¾	.....	40–600	4–60	.....	1 1/16	½ by ¾	460
9	9¼	6⅜	2½	12	.....	.....	.....	2–112	.....	3/4	.....	....
10	10½	6½	...	....	.....	.....	15–500	3–96	.....	1 1/16	½ by ¾	....
11	11¼	9¾	3	14¾	½ to ¾	.....	40–600	4–60	.....	1 1/16	½ by ¾	475
11	13¾	8¾	4	18	2	3-G	11–125	.....	50–250	.....	½ by ⅞	1050
12	13⅛	7⅞	5	31	.....	2	.....	2–56	.....	1 1/16	½ by 1⅛	1150
12	12⅝	7¼	5	27¼	1	1¾	6–320	1½–80	.....	15/16	½ by ¾	1535
13	13¼	8	5½	36	.....	2	.....	5–36	.....	1 1/4	.....	1300
13	13½	7¼	6	38	.....	2½-G	48–166	4–20	30–655	1 5/16	⅝ by 1¼	1600
14	15	9½	6	37	1½ to 2	... G	.....	2–96	12–400	1 9/16	⅝ by 1⅜	2200
14	16½	10½	6	33	.....	2½-D	2–128	1–64	16½–335	1 1/4	½ by 1	....
14	16⅞	11⅞	6	37	.....	2½-D	12–256	3–64	14–369	1 11/32	⅝ by 1⅜	1900
15	16¼	10	6	36	2 to 3	2½-G	.....	2–56	15–500	1 5/16	⅝ by 1¼	1950
15	16¼	11¼	6	31	2	3-G	12–184	3–46	15–350	1 11/32	⅝ by 1	....
15	17	10½	6	30	.....	3-D	.....	2–64	.....	1 9/16	¾ by 1½	2550
16	16⅜	11¼	6	36	3	4	5.36–150	2–56	15–350	1 17/32	⅝ by 1⅛	2750
16	17⅛	11¼	6	30	2 to 3	.....	.....	2–56	.....	1 5/8	⅝ by 1⅜	3000
16	18½	12¼	6	31	2 to 4	4-G	.....	2–112	10–360	1 5/16	⅝ by 1¼	....
17	19	11	6	28	.....	3½-D	6.33–100	3–46	13–360	1 9/16	¾ by 1½	....
17	17¼	10¾	6½	34	.....	3½-D	.....	2–48	.....	1 7/16	⅝ by 1⅛	2300
18	18⅜	11¾	6	25½	.....	3¼-D	.....	3–46	10–320	1 3/8	⅝ by 1¼	2540
18	18⅜	13⅛	6	31	4	4-G	5.36–150	2–56	14–300	1 17/32	⅝ by 1⅛	3600
18	20¼	12½	6	26	5	3-D	2.50–160	1–64	12–350	1 9/16	¾ by 1½	....
19	21	13	6	28	.....	3½-D	6.33–100	3–46	.....	1 9/16	¾ by 1½	....
19	19⅜	13⅛	8½	52	.....	3¾-D	.....	2–32	.....	1 11/16	⅝ by 1¼	2800
20	21¾	15⅝	6	28	5	3½-D	8–184	2–46	9–274	1 29/32	¾ by 2	4120
20	22½	14½	8	45¾	7½	4-G	2.5–160	1–64	13–354	1 3/4	¾ by 1½	4250

*Specifications for lathes of various makes. †Double back-gears marked D; geared head, G.

MACHINERY'S Data Sheet No. 37, New Series, July 1924

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ENGINE LATHE SPECIFICATIONS*

Swing, Inches			Length of Bed, Feet	Maximum Distance between Centers, Inches	Horsepower of Motor, if Motor-driven	Belt Width, Inches, if Belt-driven†	Range of Feeds per Inch	Range of Threads per Inch	Spindle Speeds, Minimum, Maximum, R.P.M.	Diameter of Hole in Spindle, Inches	Size of Tool, Inches	Net Weight, Pounds
Nominal	Actual over Bed	Actual over Carriage										
20	20½	13½	10	82	5	4-G	.....	.....	18–470	1 9/16	¾ by 1½	3250
22	22½	14	8	41	.....	4-D	.....	2–28	10–298	1 13/16	⅞ by 1¼	.....
22	22½	14⅛	8	37½	.....	4-D	7–111	2–40	11.7–346	2	1 by 1½	4900
22	23	15	8	42	.....	4¼-D	.....	2–30	10–300	2	¾ by 1½	.....
24	25¼	17	10	54	5 to 7½	4½-D	2–143	1–24	.....	2 3/8	¾ by 1½	7400
24	27½	18	10	58¼	7½	5-D	4.5–252	½–28	8–250	2 1/8	⅞ by 2	.....
24	26¾	18½	8	40¼	7½	4½-D	6–144	1–24	6–225	2 5/8	⅞ by 2	.....
25	27½	18¼	12	69	15	5-G	5.4–333	¾–46	8–300	2 1/4	⅞ by 1¾	10,100
25	27	19	10	....	.....	4-G	4.5–200	2–46	11–200	2 3/16	⅞ by 1¾	7400
26	27½	19¾	10	54	.....	4½-D	2–143	1–24	.....	2 3/8	¾ by 1½	7750
26	26½	17½	10	60	10	4½-D	.....	.....	12–275	2 1/8	⅞ by 2	6800
27	27½	18¼	10	51½	15	4½-G	5–80	1–16	9–313	2 3/8	¾ by 1½	7900
27	30½	22⅝	10	47¼	10	4½-D	1.37–88	1–32	9–313	2 1/8	1 by 2	8600
28	28⅜	19⅜	10	47¼	.....	5½-D	7.2–143	½–28	7.8–246	2 1/4	1 by 1½	8200
28	28¼	19½	12	84	10	5-G	.....	.....	12–275	2 1/8	⅞ by 2	7100
29	29¼	20¾	12	88	.....	4½-D	.....	1–56	.....	2 1/8	¾ by 1¾	6500
30	34½	....	10	51	.....	6-G	.....	½–28	.....	2 5/8	1 by 2	.....
30	31¾	22¼	10	45	.....	... G	2.7–39	1–14	6–260	.....	.....	.....
32	32¾	22⅞	10	35½	.....	5¾-D	6.2–100	½–28	6.4–236	2 5/8	1 by 2	11,000
32	33	22	10	36	10 to 15	8-G	.....	.....	.....	1 7/16	.....	15,100
36	37	24¾	12	52	7½ to 10	4-T	0.8–52	¼–16	.....	3 1/16	1 by 2	17,000
36	36½	26	12	....	.....	4-D	.....	.....	3–260	.....	1 by 2	12,400
42	43½	32½	12	44¾	.....	5-T	2.7–130	½–24	1.5–250	3	1 by 2	16,500
42	43½	33¼	12	53	20	7-T	1.37–77	1–28	1.85–240	2 1/8	1 by 2	17,500
48	52½	42¼	12	35¾	25	7-T	1.5–84	1–14	1.4–223	2 1/8	1½ by 2½	30,750
60	61	50	12	36	25	7-T	1.5–84	1–14	1.2–187	2 1/8	1½ by 2½	33,750
72	73½	54	20	108	40	... T	.....	1–14	1.9–41	2 3/4	.....	59,000

*Specifications for lathes of various makes. †Double and triple back-gears marked D and T, respectively; G, geared head.

MACHINERY'S Data Sheet No. 38, New Series, July 1924

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The British Metal-working Industries

From MACHINERY'S Special Correspondent

London, June 14

JUDGING by the orders on the books of engineering firms, the industry as a whole is in a considerably better position than at this time last year, or even as recently as ten months ago. It is feared, however, that a large number of the orders in hand are being filled at prices that show only the barest margin of profit.

At a conference between employers and trade unions' representatives held recently to discuss the present position of the engineering industry, it was stated that an analysis of over 1000 firms representing more than 60 per cent of the total employing power of the Employers' Federation showed that the average annual dividend on money invested in the industry was only 2.73 per cent and this figure has been further reduced by later returns. It is generally granted that the claims of engineering workers for increases ranging from 10 to 20 shillings per week are reasonable, especially in view of the rates of pay that are current in other trades and many unskilled occupations. Such wage increase, however, would at the present time undoubtedly result in losses in the case of the majority of firms.

The Machine Tool Industry

The machine tool industry shows no striking development; in all machine tool building districts, firms are able to keep going without, however, approaching to capacity in output, except in a few notable cases. Makers generally are hopeful of a steady improvement, but in the meantime there is extremely keen competition for such orders as are given out. Of the various machine tool centers, the Midlands shows the most hopeful outlook, and good progress is reported by several makers. The demand for standard machines has revived, and one of the largest producers engaged exclusively on turret lathes is running day and night. The demand for power presses is brisk, and there is an increasing demand for hydraulic presses and pumps from France, Belgium, and Switzerland. Makers of drilling and milling machines are well employed.

The Manchester area also shows an improvement in machine tools. Indian and Colonial railways have recently placed several orders which include turret lathes, horizontal boring machines, milling machines, and special machinery. Other districts show little change during the past month. Makers of radial drilling machines in the Yorkshire centers are fairly well occupied and builders of planers have had an increasing number of inquiries. In Scotland machine tool makers still have rather large stocks of general-purpose machines, and foreign business is confined to the heavy class of machine tools.

Overseas Trade in Machine Tools

During April there was a slight increase in the exports of machine tools, the tonnage being 837 with a value of £91,200—figures that are approximately equal to the averages of the first three months of the year. The exports in April were 66 per cent of the average tonnage for the period 1911 to 1914. Imports fell off, amounting to only 243 tons, with a value of £32,900. The value per ton of exports remained at about £108 to £110 but that of imports continued to fall from the high figure of £180 reached last January, the figure being now only £136 per ton. All classes of machine tools with the exception of presses were exported in greater numbers than those coming into the country. The most prominent machines among exports were lathes, which reached a value of over £38,000.

Mention may be made of a new plate and girder radial drilling machine recently introduced by William Asquith Ltd., Halifax. The most important feature of this machine —the subject of a patent—is that one movement of a lever not only locks the arm and saddle but starts the machine as well. The reverse movement of the lever stops the machine and unlocks the arm and saddle. This provision not only saves much time where several holes have to be drilled, but also prevents the operator from starting the drill without applying the locks, a practice that results in frequent drill breakages.

General Engineering Field

The engineering industry generally shows a steady improvement. Public bodies continue to place important contracts that affect directly or indirectly a large number of industries. Orders continue to be received by railway car builders, and this is now one of the busiest branches in the engineering industry. Locomotive builders report a steady improvement; although the total number of locomotives ordered in the last month or two is not very large, when spread over the various firms interested. Orders for locomotives for Brazilian railways have recently been received, and as in the case of most foreign railways the orders have been obtained in the face of severe American and Con tinental competition.

Electrical shops are generally well employed. Structural shops, including crane builders, are receiving a sufficient number of orders to keep them busy for some time. It is also gratifying to note an improvement in the textile machinery industry, and though the improvement is only slight, the turning point has come more quickly than was expected. This renewed activity is on account of overseas demands, America being prominent among the inquirers. Foreign competition is not felt in this industry, which has fully regained its pre-war prestige, even in certain eastern areas that a few years ago proved very profitable to American textile machinery makers.

The Automobile Industry—Shipbuilding—Iron and Steel

Demand in the automobile industry has fallen off considerably during the last few weeks, this being generally attributed to the repeal of the 33 1/3 per cent import duties on foreign cars, which is to take effect in August of this year. Purchasers of light cars are apparently waiting to see what reductions will be made in the prices of foreign cars before placing their orders. The fall in demand coming at a season when the industry looks for its biggest crop of orders has created a condition of considerable uncertainty and substantial reductions have already been made in the number of men employed by firms making light cars.

The conditions on the Clyde have improved since the shipbuilding dispute was ended. A good deal of tonnage is under construction and all the yards have work in hand, while at the same time a large number of vessels are undergoing repairs.

The upward movement in Sheffield's steel industries continues to make headway steadily, if slowly. Raw materials are being bought more freely, there are less workmen out of work, and the number of firms who may be considered well employed, gradually increases. The position with some firms is better than at any period during the last three years. A promising feature is the increasing number of inquiries and orders coming from the shipbuilders for heavy castings and forgings.

Current Editorial Comment

in the Machine-Building and Kindred Industries

With great regret we announce the resignation, to take effect on August 1, next, of Mr. Matthew J. O'Neill, Treasurer and General Manager of the Industrial Press, with which he has been connected for more than twenty-six years, and to which his unusual business ability and untiring energy have been invaluable.

Mr. O'Neill is withdrawing from active connection with this company in order to devote all his time to other business interests.

* * *

LOOK OUT FOR PATENT RIGHTS

Designers of machinery sometimes have made such use of mechanisms and devices protected by patents as to render themselves liable to suits for infringement, and a word of caution in this connection may be helpful.

Sometimes a designer obtains an idea from a catalogue or an article in the technical press that is applicable to the design of a mechanism on which he is working at the moment, and makes use of this idea without giving any thought to the possibility of infringement. It is impracticable for a technical journal always to specify when the mechanisms and designs it describes are patented; but the designer who incorporates a new or unusual mechanism in a machine to be built, should obtain that information.

MACHINERY describes mechanisms in use on machine tools and other kinds of machinery for the purpose of keeping its readers fully informed on current mechanical practice; but the description of a device in a mechanical journal does not imply that it is public property or that it can be made use of without permission, in another mechanism. A designer can determine when he can legally use a mechanism only by having a search made in the Patent Office, and this should be done before any unusual mechanism is incorporated in a new design.

* * *

MACHINERY REPLACEMENT

Machine tool builders generally consider that the replacement of obsolete machinery offers the best prospect for business during the immediate future. To make a successful bid for such business, a machine tool builder not only must offer new designs of such productive capacity as to warrant the replacement of older machines with new ones, but he must be able to present specific figures to show that they effect savings which warrant buying them. It is not always simple to calculate the actual savings on a new machine, because several factors enter into that problem.

A paper by A. L. DeLeeuw, dealing in great detail with this question, was presented at the spring meeting of the American Society of Mechanical Engineers; this paper is worth careful study by both builders and users of machine shop equipment. Mr. DeLeeuw outlines the methods to be followed in determining the most economical way of machining work, either in large or small quantities, and calls attention especially to the difference between the saving of labor cost and the ultimate economy.

A point often overlooked is that the method that gives the highest ultimate economy in the final cost of production is the best, and not always the one which shows the greatest saving in a single operation. Many manufacturers have adopted a highly efficient method for performing one operation, without considering that it may increase the cost of either previous or subsequent operations.

Another factor to be considered is that a method may be highly effective under one set of conditions and of little use under another. For example, the most economical way of rough-turning a piece of work that is to be ground afterward, is not necessarily the best way if the piece is to be finish-turned in a lathe. And the best method of machining when a steady stream of work passes through the shop, may not be satisfactory when the work is intermittent.

A thorough study of all factors entering into the cost of production might relegate to the scrap heap thousands of machine tools that are actually obsolete, although their owners may not think so. If the waste resulting from the use of obsolete machines and methods could be estimated in dollars and cents, it would undoubtedly prove to be a staggering amount.

The automotive industry, which is justly considered the best equipped of all our machine-building industries, continues to use many obsolete machines and methods. In the opinion of a works manager whom we consider unusually well informed on the subject of automotive shop equipment, the efficiency of our automotive shops could be greatly increased if about 50 per cent of the present equipment were replaced with the best machines now available for performing the same kind of work.

* * *

QUANTITY PRODUCTION THAT DOESN'T PAY

In a recent editorial, "Wasteful Quantity Production," we suggested that manufacturers having a comparatively limited output should consider carefully the difference between quantity production for immediate requirements, as in the manufacture of automobiles, sewing machines, typewriters, cash registers and similar products, and the making of quantities of parts in such lines of machine-building as those in which the parts may not be used up for years.

The production department is sometimes too inclined to believe that quantity production is always advantageous, and it is often difficult to convince the production man that the firm sometimes makes money by producing in smaller quantities at a higher unit cost per piece, because the cost of carrying parts in stock, due to interest charges and other overhead costs, amounts to approximately 1 per cent a month, which must be charged against the savings made by producing in larger quantities. It is evident that if the saving due to quantity production were only 10 per cent, it would be wasteful to produce parts that were to be held one year or more. Some machinery builders have found that by manufacturing in quantity they saved only 5 per cent, while the cost of carrying the parts in stock for a period of three years represented 36 per cent of the cost of the parts. Such facts, brought to the attention of the management of machine-building plants, will suggest the need for a careful study of not only production costs, but of the cost of carrying completed parts in stock over long periods.

At a regional meeting of the National Machine Tool Builder's Association, the problem of keeping parts in stock for long periods and of the turnover of inventory received attention. Several members said their experience showed that by redesigning machines so that more parts would be interchangeable on different sizes and types of machines built, a considerable saving in production had been effected. Another successful method of reducing the inventory and increasing the turnover is to eliminate unnecessary sizes.

Forty Years Selling Machine Tools

By ALBERT R. STEDFAST, Secretary and General Manager, Hill, Clarke & Co., Inc., Boston, Mass.

DURING the forty years that I have been connected with a concern selling machine tools, I have seen the machine tool industry change from comparatively small beginnings into one of the great key industries of America. Extensive plants have developed from small beginnings, crude and simple machine tools have evolved into high-production machines with many refinements in design. The selling of machine tools has also gone through great changes. In the days when I first came to Hill, Clarke & Co., the office was always known as the "counting room," and the methods followed were very different from those applied today.

In this period of forty years the machine tool industry has gradually developed in a westward direction. From small beginnings, the shops in the middle-western states have become substantial rivals of those in the East. The leaders in the industry have constantly been on the lookout for new ideas. They have had a great deal of courage, and have often spent all their profits in experimenting with new developments.

Among the outstanding men in the machine tool industry that I personally knew in the early days, were Amos Whitney, William Gleason, E. P. Bullard, Sr., and George Gray. All of those men have now passed away, but the businesses that they built still take their places among the leading machine tool shops of the country.

On July 7, Albert R. Stedfast completes forty years of continuous service with Hill, Clarke & Co., Inc., Boston, Mass. On July 7, 1884, he started with this concern as office boy. Later he was employed on sales work in the company's store, and in 1898 took up the duties of a traveling salesman. He has held his present position as secretary and general manager since 1912. In this article Mr. Stedfast relates some interesting reminiscences.

Selling Machine Tools in the Early Days

When I first started to sell machine tools, purchasers were prone to want to buy machines by the pound. This applied especially to planers and boring mills. A common price for planers was 10 cents a pound. In fact, not much more than twenty years ago, a 48- by 48-inch by 16-foot planer weighing 27,000 pounds could be bought for $2520. Other machine tools were priced in proportion. A 24- by 24-inch by 6-foot planer was quoted at $535. A 30-inch by 10-foot lathe with compound rest was sold for $770; a No. 2 plain milling machine with all power feeds, for $525; and a 25-inch upright drilling machine for $235. A 2½-inch horizontal boring machine, weighing 4700 pounds, was sold for $850; and a universal grinder, 12- by 66-inch, for $900.

These prices were made possible by the small costs in those days. There were no income taxes to be paid, and what taxes there were, were proportionately much less than today. A first-class machinist could be hired for from 22 to 25 cents an hour, and good toolmakers received from 30 to 32 cents an hour. Apprentice boys started in at 4 cents an hour, and never got more than about 10 cents an hour in their last year. Selling expenses were also much less, because railroad fares and freight rates were only about one-half of what they are today, and hotel expenses were considerably less than one-half.

The greatest impetus to changes in machine tool construction was the advent of high-speed steel, which was spoken of as a novelty in many shops only twenty years ago. Old-time machinists opposed the new steel, because they could not understand that it was possible to use a tool successfully with a red-hot cutting edge. They wanted to run the tool in their own way, which meant at the same speeds as for carbon tool steel, and at those low speeds, when the high-speed steel was cold, it did not, in fact, cut as well as carbon steel. Most machine tools were too light for the heavy cuts and high speeds possible with high-speed steel, and complete redesigning of practically all types of machine tools was found necessary. It is only within the last few years that this redesigning process has fully met the requirements of the new cutting material.

Accurate Lathes of the Past

Perhaps the most accurate lathes ever built were constructed some thirty or thirty-five years ago. They were known as Ballou lathes, of which three were built having a swing of 14 inches and a 6-foot bed. The lead-screws of these lathes were claimed to be accurate within 0.0001 inch per inch. They were made for laboratory work.

The biggest advance in machine tool design during the period that my experience covers, I think, is the introduction of the single-pulley drive with geared feeds and speeds. In the lathe field, the hollow spindle lathe was also a great innovation, and in its earliest days there were few manufacturers who wanted to build lathes in that way.

Unusual Experiences in Selling Machine Tools

In going over my reminiscences of forty years, I think that the most unusual sale made was of four lathes which were disposed of without the slightest effort on the part of the salesman. These machines were being trucked by a horse-team from the freight depot to the storehouse, four of them being loaded on one truck. A man who just happened to need lathes of the same types and sizes as those loaded on the truck saw the team in the street and followed it to the storehouse, where he asked if the lathes were for sale. Being told that they were, he said, "Don't take them off the dray; cart them right over to my place and put them down on the floor." He made out the check for the purchase in full then and there, and the lathes were taken directly to his shop.

In the early days, machine tool dealers handled not only machine tools but also woodworking machinery, engines, boilers, and miscellaneous other types of machines. Among other machines that we sold were Otto gas engines. In our store we ran one of these gas engines on city gas, driving a dynamo with it and producing our own electric light. A

saw mill owner from Maine came into the store one day to buy a saw table, and became much interested in the electric light and the means of producing it. He had the whole system explained to him and inquired about the cost of the gas and how much was used by the engine. Apparently he had no idea about the nature of city gas, however, because within a few days we received an order from him for one of the gas engines, a dynamo, and full equipment for "making electric light," together with "100 gallons of gas," and he further requested that "gas would be shipped to him at regular intervals."

Another prospective purchaser in those days, after having had the advantages of the hollow-spindle lathe, which was then a novelty, thoroughly explained to him, inquired in all sincerity whether we did not also carry some hollow-spindle planers. I mention this instance particularly because there has been a remarkable change in the knowledge of the buyers of machine tools. Today the buyer sometimes seems to know more about the machines than the salesman. He certainly often knows more about the competing machines. To the intelligent salesman this change is welcome, because it is much easier to sell a good machine to a man who understands what you are trying to sell him than to men who are unfamiliar with the features and advantages of different types of machines.

* * *

MACHINE TOOL EXHIBIT AT RAILWAY CONVENTION IN ATLANTIC CITY

The exhibit of machine tools and shop equipment, as well as of railway equipment in general, held in connection with the convention of the American Railway Association at Atlantic City, June 11-18, was the largest of its kind ever staged at any of the railway conventions. The attendance at the meeting was also greater than ever before, the total registration of members of the American Railway Association and supply men being over 5000. There were 384 exhibits separately entered, but the number of firms having products on exhibition was much greater than this, because in many cases dealers exhibited the products of several of the firms that they represent. Of these exhibits, over fifty represented machine tools, and an equal number, small tools and shop equipment of various kinds.

Practically every class of machine tool generally used in railroad shops was represented, and one of the valuable features of the exhibition was that most of the tools were shown in actual operation. The visitor was especially impressed with the great development that has taken place in machine tool design during recent years. The chips taken by some of the machines would have been considered impossible some fifteen, or even ten, years ago. An equally remarkable development in small tools was made evident by actual tests conducted during the exhibition.

The machinery hall set aside for the exhibition and demonstration of machine tools was found inadequate to accommodate all the exhibitors of machine tools who applied for space, and it became necessary to erect an annex on a space adjoining the pier where the exhibition was held, for the overflow exhibits.

Practically all the new machines and tools exhibited have been illustrated and described in MACHINERY during the past year, and there is, therefore, no need of a detailed description of the exhibits. If the mechanical industries of the country, and the railroad shops in particular, could and would take advantage of the improved equipment shown by the machine tool builders at this remarkable exhibition, there is not the slightest doubt but that a very great increase in efficiency and reduction in the cost of performing machine shop work could be brought about.

* * *

The number of employes on American railroads for the year 1923 averaged 1,879,770.

THE METAL INDUSTRY OF NEW YORK AND VICINITY

A comprehensive report entitled "The Metal Industry in New York and its Environs," has recently been published (price, $1) by the Regional Plan of New York and its Environs, 130 E. 22nd St., New York City. The outstanding facts revealed by the investigation are quite interesting, and may be briefly reviewed as follows:

Since 1900 metal manufacturing in New York and its environs has changed from a predominantly heavy industry to a predominantly light industry, the heavy branches having grown slightly and the light branches very greatly. The metal industry is the largest single employer of labor in New York and its environs, using the services of more than a quarter of a million workers. The number of employes has increased 79 per cent since 1900, whereas the number of plants has nearly trebled. Small plants have been increasing at a much more rapid rate than large plants. In 1900 more than one-third of the plants employed at least 20 men each. In 1920 less than one-fifth of the plants were as large as this.

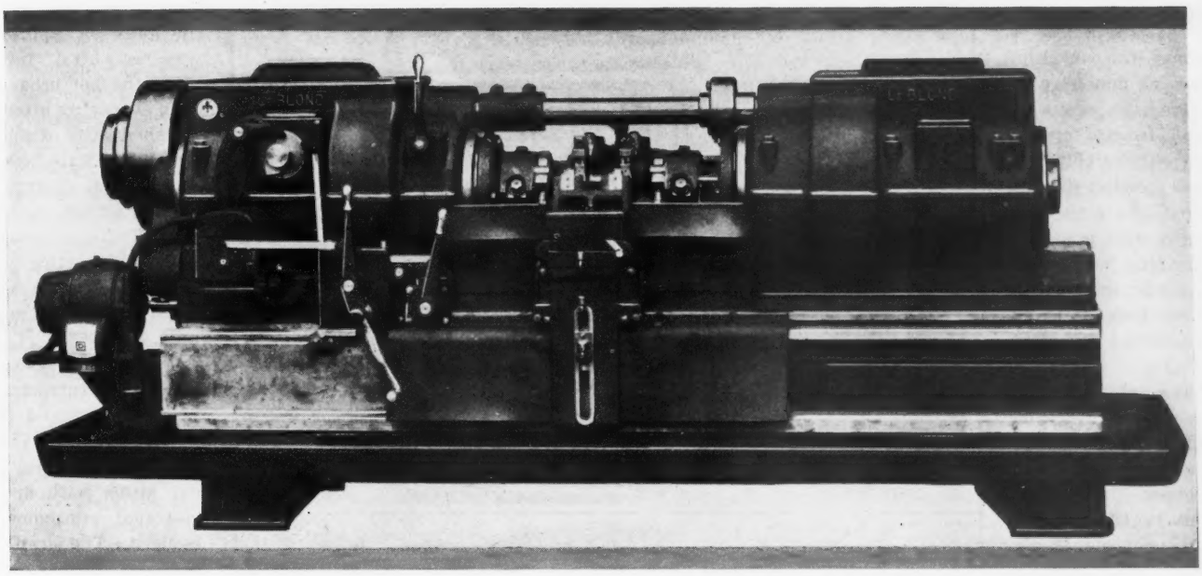
The typical metal plant now employs only 29 workers, as compared with 47 workers in 1900. The plants in the center of the region average only 13 employes per plant, while those in the outlying area employ, on the average, 57 persons. In Manhattan, south of 59th St., there are less than half as many heavy metal workers as there were in 1900. In 1900 there were thirty-five large metal plants producing heavy and bulky products in Manhattan, south of Canal St. In 1922 there were only twelve such plants in this area. Only five iron foundries remain on Manhattan Island, whereas at one time there were sixty-five. Plants on Newtown Creek and about Perth Amboy and Newark refine 55 per cent of all the copper refined in the United States.

In recent years plants producing heavy and bulky metal products have shown a strong tendency to move from Manhattan and Brooklyn to Queens and New Jersey. The growth of plants of this type for the area as a whole has been relatively slight. The metal industry in New Jersey continued to grow steadily after the war, while all the other sections of the area (except Queens) suffered declines. New Jersey is not only absorbing the major part of the natural growth of the industry, but is also attracting plants from other localities. Plants producing heavy and bulky metal products, which in 1900 occupied much of the East River waterfront, have for the most part retreated inland. The division of the metal industry which has increased its number of employes most rapidly since 1900 is that producing technical instruments, supplies, and fixtures. Such plants have nearly trebled their employes, the growth having been particularly marked in New Jersey. Owing largely to the increase in the number of service and repair shops, the group in which such plants fall increased their employes from 32,484 in 1900 to 92,299 in 1922.

Manhattan makes between 80 and 85 per cent of the fine jewelry of the country, and Newark between 90 and 95 per cent of the medium-priced product. Plants making high-grade jewelry, formerly centered in Manhattan south of 14th St., have moved north toward the middle of the Island. The lighter the industry and the finer the grade of work turned out, the higher the value of the land on which the establishment tends to locate. The analysis seems to justify the prediction that much metal manufacturing, especially the large-scale heavy branches, will continue to move from the center toward the outskirts of the Metropolitan area and even beyond the limits of the area entirely.

* * *

The railroads in the United States handle approximately 70,000,000 pieces of baggage every year. If the value of each piece is estimated at $100, which is conservative, the total value of the baggage carried is $7,000,000,000. This large amount is carried at a comparatively slight risk, and not more than one piece in a million is lost beyond recovery.



Machining Automobile Crankshafts

A New Manufacturing Method Involving the Use of an Automatic Crankshaft Lathe in Conjunction with the Multi-cut Lathe

By W. E. GROENE, R. K. LeBlond Machine Tool Co., Cincinnati, Ohio

IT is doubtful if there is any automotive part, the machining of which has been given more consideration than crankshafts, or any part on which equal strides have been made in the advancement of production methods. The machining of a crankshaft involves problems of great complexity. It combines difficulties of chucking, driving, alignment, and variations of forging contour, coupled with material that is necessarily of exceptional toughness. These difficulties have now been successfully surmounted, and when one reflects upon the comparison of present quantity production methods, where the machining of a pair of crankpins is a matter of seconds only, with the former single-tool, one-pin-at-a-time method, the achievement seems really remarkable.

It is impossible to establish any definite rule or procedure for machining automobile crankshafts, owing to the many variations in the design of these parts. The method of machining and routing is determined in each case by the nature of the crank itself. Some automobile manufacturers prefer to center their cranks with a depth gage, and then regulate all machining operations from these crank centers. Still others prefer to do their machining with reference to the center line bearing, which in this case is machined first, the crank being gaged from the cheeks of the center bearing, and when in position, supported by adjustable centers. The latter method is probably preferable, as the greatest mass of metal is generally at the center, and if gaged in relation thereto will result in a better dynamic balance.

A crank machined by the latter method has been selected as an example of crankshaft turning. This crankshaft is of the six-throw type, and is for one of the well-known better grades of cars now on the market. It has two center line bearings and a unit counterbalance, the diameter of which is slightly reduced if necessary when balancing to secure perfect balance. The various turning operations on this typical six-throw crankshaft, which are to be described briefly, are performed on a LeBlond No. 4 automatic crankshaft lathe. This lathe, which is a recent development, is of the duplex type, and is essentially a forming lathe, as both front and rear slides are fed into the work at right angles to the axis of the centers (see the heading illustration). It is equally adapted for turning crankpins and line bearings, and when used in conjunction with the LeBlond multi-cut lathe, shown in Figs. 2 and 3, offers practically a new manufacturing method for crankshafts.

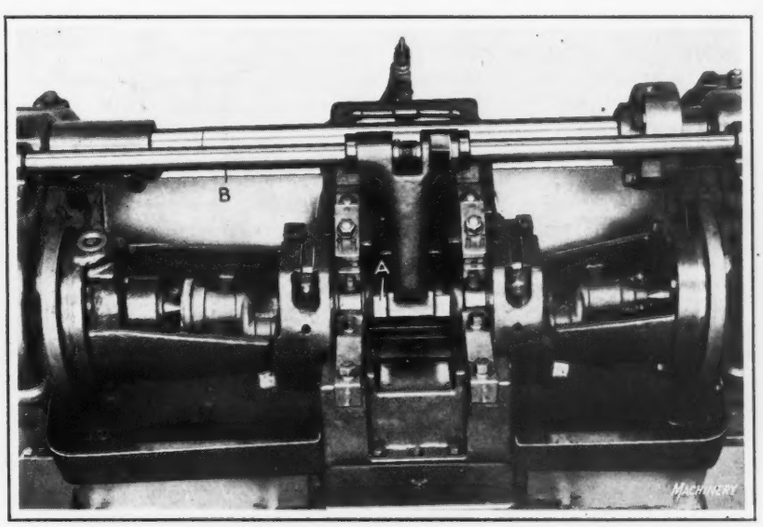


Fig. 1. Machining Inside Line Bearings of Six-throw Crankshaft on Automatic Crankshaft Lathe

The preliminary operations include a laboratory test together with sand-blast, straightening, and centering operations. The centering operation is in some cases to a standard depth gage, so that duplicate location in relation to the cutting tools can be obtained, although this is not necessary in this particular instance. The first turning operation includes turning and filleting the center line bearings. For this operation the automatic crank-

shaft lathe is used, as shown in Fig. 1. Since the machine has a double-end drive, the crank is held in two special pot chucks bolted to the spindle flanges. Each chuck is provided with a hinged clamping jaw having a hardened liner, these jaws gripping the second and fifth pins.

The chucking of the crank is accomplished as follows: The part is first dropped into position in the chucks, and is properly located longitudinally in relation to the tools by a swinging locating plate *A* mounted on a bar *B*, which extends between the headstock and tailstock. This plate is made to locate the crankshaft from the forging contour in the space between the bearings to be turned, and after location is accomplished it is raised out of the way. While the locating plate is still in position, the spindle centers are caused to engage the crank, one center being air-controlled and the other having screw adjustment. The chuck jaws are then clamped, the locating plate removed, and the crank is ready for machining.

The machining is accomplished by one front and one rear facing slide, each carrying two tool-holders for machining both line bearings simultaneously. The tools on the rear slide—two in each holder—are vertical tools, their function being to do the necessary cheeking and filleting. The front tools are of the square-nose type, and they remove the metal left between the two rear tools. Both slides are fed directly into the work, the operation being actually one of forming. They perform their functions simultaneously and are tripped at the same time. The machine is controlled automatically, the feed being tripped, the spindle stopped, the return traverse engaged, the traverse tripped, and the cutting lubricant shut off automatically. The feed-trip and spindle-stop are so arranged that after the feed is automatically tripped, the spindle continues to revolve for a predetermined number of revolutions before being stopped automatically. In this way, the pin is accurately sized, all chatter and size variations due to the spring of the material being removed. The turning time per pair of pins is approximately two minutes, the net production averaging fifteen finished pairs of pins per hour. This lathe is capable of duplicating within very close limits, although general practice is to turn to rough grinding tolerance only.

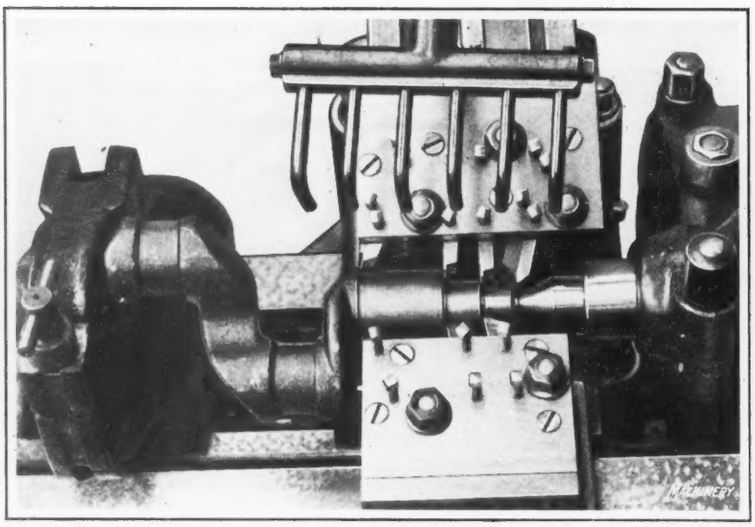


Fig. 2. Multi-cut Lathe equipped for machining Stub End of Six-throw Crankshaft

The second operation is to turn and face the stub end of the crankshaft. For this, the heavy multi-cut lathe, with special tool equipment, is used. The crankshaft is held in a special pot chuck on the spindle and is located from the previously machined rear center line bearing. A steadyrest is placed on the previously machined front center line bearing. The end of the crank is supported by the tailstock center, as shown in Fig. 2. Both pot chuck and steadyrest are provided with quick-acting hinged jaws for removing and replacing the work rapidly.

The multi-cut lathe is adapted to simultaneous turning and facing cuts. The stub end of the crankshaft is finished complete by one roughing and one finishing cut. Special tool-blocks are used on both the turning and facing slides, the front block carrying three tools for turning the three diameters of the stub, and the rear block four tools for facing the corresponding shoulders. For the finish-turning operation, an additional facing tool is added to form the usual chamfer on the thread diameter. The automatic spindle-stop and power traverse are also incorporated in this machine to increase production. As in the previous instance, the crank is machined to the usual rough-grinding allowance. The time for this operation is 1½ minutes per crank, a net production of approximately 40 per hour being obtained.

Operations on Flange End and End Line Bearings

The forging is next transferred to a similar machine for corresponding operations on the flange end (see Fig. 3). In this case the crank is held in a pot chuck on the spindle, chucked from the front center line bearing with a steady-

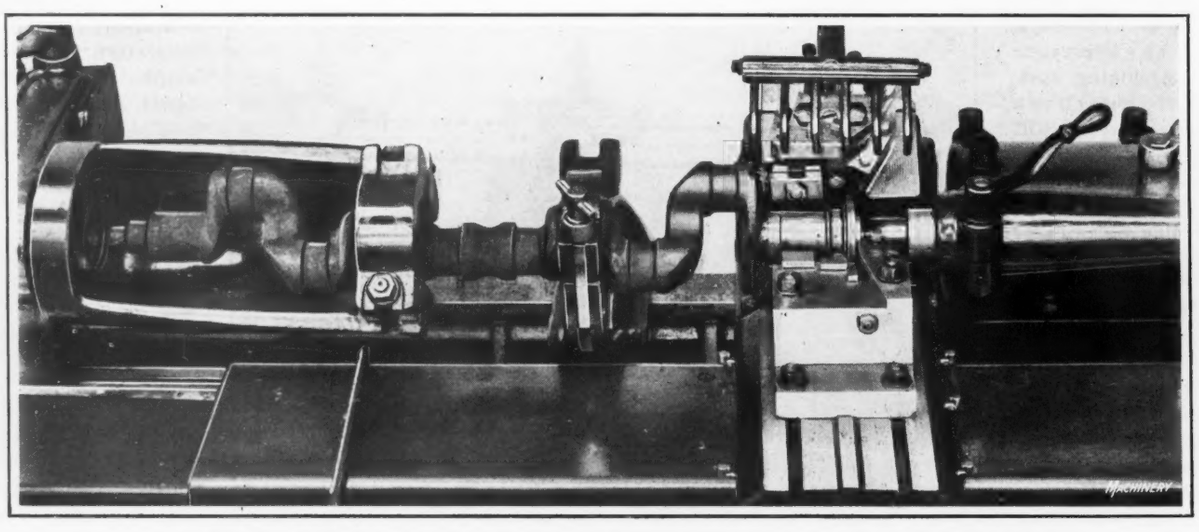


Fig. 3. Roughing Operation on Flange End of Six-throw Crankshaft—Another Application of the Multi-cut Lathe

rest on the rear center line bearing, and is supported at the far end by the tailstock center. The pot chuck and steady-rest are similar to those previously described. However, for this operation the machine is equipped with a special heavy facing slide on the carriage, as well as the regular facing attachment. The carriage is bolted rigidly to the bed, and the travel of the slides, both front and rear, is directly into the work. This change in equipment is necessitated by the shape of the flange as well as the oil-ring. This is a special adaptation of the multi-cut lathe, and gives excellent results.

The flange and end line bearing are roughed out together in one operation. Special tooling is required on both front and rear slides, each slide carrying four tools. The end line bearing is machined in the same manner as the center line bearings by two vertical tools on the rear block for the cheeking and filleting cuts, and a broad square-nose tool on the front slide for removing the metal between. The oil-ring and chamfer are finished by a form tool on the front and rear slides, while the flange itself is taken care of by a square-nose tool on the front slide for reducing the outside diameter, the front of the flange being faced by a tool on the rear slide. The remaining front tool is made to face the extreme end of the crank. This tooling is clearly shown in Fig. 3, and while it would vary somewhat for other crankshafts, it may be considered typical for machining the flange end.

After this rough-forming operation, the end line bearing itself is ready for grinding, although a finish-turning operation is generally performed on the flange alone. This operation is handled on the multi-cut lathe with the standard carriage and facing attachment, combined turning and facing cuts being performed. The crank is held with the same equipment as was used for the preceding operation. Special tooling is again required, the turning slide carrying two tools and the rear slide three tools. The front tools turn the outside diameter of the flange and shoulder on the end of the crank, while the rear tools face both sides of the flange as well as the end of the crank. The production obtainable on the roughing operation for flange and end line bearing together, is approximately 12 crankshafts per hour. The production on the finish flange operation is approximately 22 crankshafts per hour.

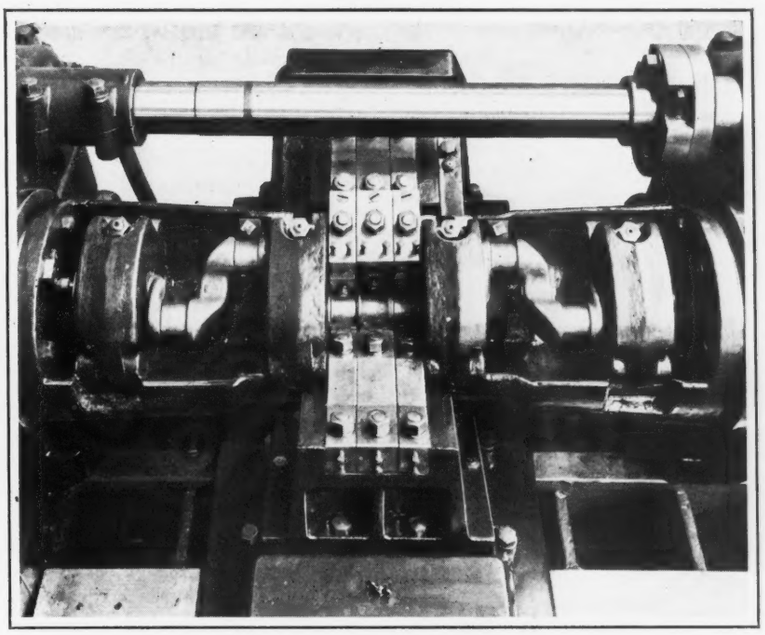


Fig. 4. Automatic Crankshaft Lathe arranged for machining Inside Crankpins and Counterbalance

Crankpin Turning Operations

The next operation is to rough-grind the end line bearings and the center line bearings. This is essential, as it insures these bearings being in perfect alignment, and since they serve as chucking points for the subsequent crankpin turning operations, it also insures the pins being in alignment and of correct throw. The end line bearings are ground first and followed by the center line bearings. The crank is then ready for the turning of the crankpins.

For the crankpin turning operations, the automatic crankshaft lathe is again used. The crank is held in hinged-jaw pot chucks, mounted on the spindles, and the first operation is to turn the first and sixth pins, the crank being chucked from the previously machined and ground line bearings. This lathe is adapted to the simultaneous turning of the two pins in the same plane, and for this operation is equipped with two front and two rear tool-slides—two for each pin. This use of four tool-slides is necessary because of the fact that the first and sixth pins are widely separated, making it impracticable to hold the tools for both pins on a single front and rear slide, as is done for the third and fourth pins. The tooling is of the same character as that used for the center line bearing, consisting of two vertical cheeking and filleting tools on each rear slide, with a single square-nose form tool on each front slide. The production obtainable on this operation is approximately 22 crankshafts per hour.

Turning the second and fifth crankpins is the next operation, and this is handled in identically the same way as the first and sixth pins. On the lathe employed for this operation the wide spacing of the pins again necessitates the use of two front and two rear tool-slides.

The final turning operation is on the third and fourth pins and the counterbalance, and for this operation the automatic crankshaft lathe is again used (see Fig. 4). The crankshaft is held in hinged-jaw pot chucks as before, but in this instance it is chucked from both inside and outside line bearings, which gives a very rigid and close coupled method of support. Only one wide front slide and one rear tool-slide are required. The rear slide carries six vertical cheeking and filleting tools, two for each pin and two for the counterbalance, and the front slide carries three tools, one for each pin and one for the counterbalance. The tool for the counterbalance is a heavy round-nose form tool, and those for the pins are of the usual form type. The time for this operation of finishing the crankshafts to grinding size is approximately 2½ minutes per crankshaft, or 22 per hour.

This is the last of the turning operations on the crankshaft, and is followed by a rough-grinding operation on the crankpins. After this grinding, the next operation is to drill all holes, including flange holes and oil-holes. The crankshaft is then cut to length and recentered, this being followed by finish-grinding operations on the crankpins and line bearings. Then come, in order, keyway cutting, thread milling, burring, and the very important balancing operations. Last of all are the polishing operations on the pins and line bearings, and the crankshaft is then ready to be assembled with the other motor parts.

Some idea of the equipment required in the crankshaft department of a well organized quantity-production automobile shop can be obtained from figures taken from the plant where the crankshaft which we have referred to, is manufactured. This plant has a production of approximately 400 cars per day of 9½ hours. It uses three automatic crankshaft lathes on the center line bearing operation, obtaining a production of 15 crankshafts per hour per machine. In addition there are two heavy multi-cut lathes to take care of the machining on the stub end; the production for each

lathe is about 30 crankshafts per hour. Four of these machines are used on the roughing operation on the flange end, the production being approximately 12 crankshafts per hour per machine. Only two lathes are required for the finishing operation on the flange end, a production of 22 crankshafts per hour being maintained. On all crankpin turning operations the automatic crankshaft lathe maintains a production of 22 crankshafts per hour, two machines being required for each pair of pins.

The equipment just outlined represents a balanced equipment. For all operations but one, the production could be considerably increased, but these operations have been slowed down to keep pace with the slowest operation, which is that of turning and filleting the third and fourth pins and the counterbalance. Owing to the large amount of metal removed, the number of cutting tools, and the wide area machined, the production is all that can be expected. Thus to maintain a continuous daily production of approximately 400 crankshafts, this company has installed nine automatic crankshaft lathes and six heavy multi-cut lathes, or a total of fifteen machines.

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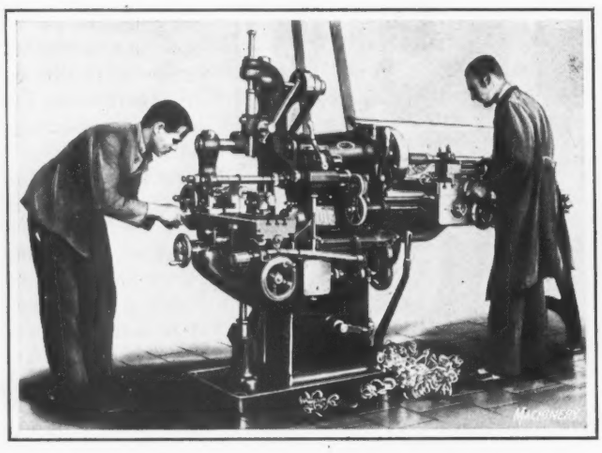
A COMBINATION MACHINE TOOL

The accompanying illustration shows a combination machine tool that has been brought out by a machine tool builder (Ernst Krause & Co.) in Vienna, Austria. As will be seen from the illustration, this machine incorporates a lathe, a milling machine, and a drilling machine, all receiving power from the same head. The machine is also used as a shaper, the milling machine table being lowered a sufficient amount so that a shaper ram mounted in the lathe bed beneath the head is free to traverse across the table. Grinding operations can also be performed by the use of a grinding head.



Combination Machine which can be used as a Milling Machine, Lathe, Drilling Machine, Shaper, and Grinder

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INSPECTION OF ENGINES AT THE FORD PLANT

Balancing, as practiced in the production of the Ford automobile, was described at a recent meeting of the Detroit Section of the Society of Automotive Engineers by Thomas Clendening. The accuracy demanded by the Ford Motor Co. in its production work is not generally appreciated among engineers. Many erroneous impressions were dispelled by Mr. Clendening's statement of the Ford tolerances and methods, which are comparable with practice in factories building expensive cars. For example, fifteen parts of the Ford engine have machining limits of 0.0005 inch, and the gages for these parts are checked every eight hours, and in some cases every four hours. It has been found more satisfactory to assemble the engines at the main factory instead of at the branch assembly plants, because less time is required and more uniform engine performance is obtained.

PRESIDENT COOLIDGE ON THE INCREASE IN SALARIES OF POSTAL WORKERS

In vetoing the bill passed by Congress to increase the salaries of postmasters and employes of the Postal Service, President Coolidge pointed out that this bill would have added approximately $68,000,000 to the annual expenditures of the Government, and said that "before such obligations are created, it should be conclusively shown that they are essential to the best interests of the nation. Government extravagance must stop. . . . The needs of the public, the ability of the people to pay, must have some consideration. These salaries have been adjusted three times since 1918, the last time in 1920. Since then the cost of living has decreased, rather than increased.

"The postal service rendered the public is good. The service conditions under which the employes perform their duties are probably more satisfactory than ever before in the history of the Post Office Department. The Government has been solicitous of the welfare of postal employes. Their compensation has been the subject of several recent legislative acts and adjusted to scales of pay as favorable as any in the public service. . . .

"At the request of the committee which considered this legislation, the Post Office Department made a special investigation of the range of salaries paid to persons employed in the business institutions throughout the country and reported the results. These investigations covered representative cities ranging in population from 2000 to over 5,000,000. It was found that in all cases of employes of a similar character the average salaries paid were much lower than those paid in the Postal Service. . . .

"The Post Office Department is now engaged, by direction of Congress, in a cost ascertainment for which half a million dollars was appropriated. This inquiry has been prosecuted with diligence and is nearing completion. When the results of this inquiry are available, they will form the basis for an intelligent consideration by the Postmaster General and by Congress of all questions relating to the adequacy of postage rates. They will afford a proper basis for consideration of the relation of the cost of the Postal Service and the revenues derived therefrom. The time has arrived to consider putting the Postal Service on a sound business basis, so far as expenditures are concerned. It is apparent that the matter of increasing the salaries of postal employes should be considered in connection with the ways and means whereby the postal revenues may be correspondingly increased, not apart therefrom. This report will be available when the Congress convenes in December, and this matter can then be considered."

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MACHINERY EXPORTS DURING 1923

A recent issue of Commerce Reports contains complete tabulated information relating to the exports of industrial machinery from the United States during 1923. The value of these exports amounted to $123,598,000, an increase of approximately 10 per cent over the exports in 1922. It is the first time since 1920 that the exports of industrial machinery have shown an upward trend. On a dollar basis, the 1923 exports were about 150 per cent in excess of the exports in 1910 and about 40 per cent in excess of those in 1913. Assuming prices to be about 80 per cent higher than those of pre-war years, the actual volume of exports will be seen to be about 40 per cent greater than in 1910, but about 20 per cent less than in 1913.

Canada was the leading customer of the United States for industrial machinery in 1923, followed by the United Kingdom, Japan, Cuba, Mexico, Australia, France, British India, Argentina, Chile, China, and Brazil, in the order mentioned. From this it is evident that the non-European trade has become much more important in industrial machinery to exporters in the United States than the European trade, which was of the greatest importance before the war.

Unusual Engine Lathe Operations

Prize-winning Articles in MACHINERY's Contest on Interesting Lathe Practice—First Installment

WORM GRINDING IN THE LATHE

By JAMES W. ARMOUR
Production Manager, Detroit Plant, Sanford Riley Stoker Co.

ONE of the most difficult problems with which we recently have had to contend is the grinding of a worm. This worm, shown mounted between the lathe centers in Fig. 1, has a triple thread with a 1-inch pitch, giving it a 3-inch lead. The pitch diameter of the thread is 2.076 inches, the outside diameter 2.6542 inches, and the root diameter 1.407 inches. The included angle formed by the sides of two adjacent threads is 31 degrees 47 minutes, and the length of the worm or threaded section is 5 inches. The worm is made of soft steel, carburized and hardened. As the hardening process has a tendency to warp the worm slightly, it is desirable to grind the threads to remove the inequalities and at the same time produce a smooth surface.

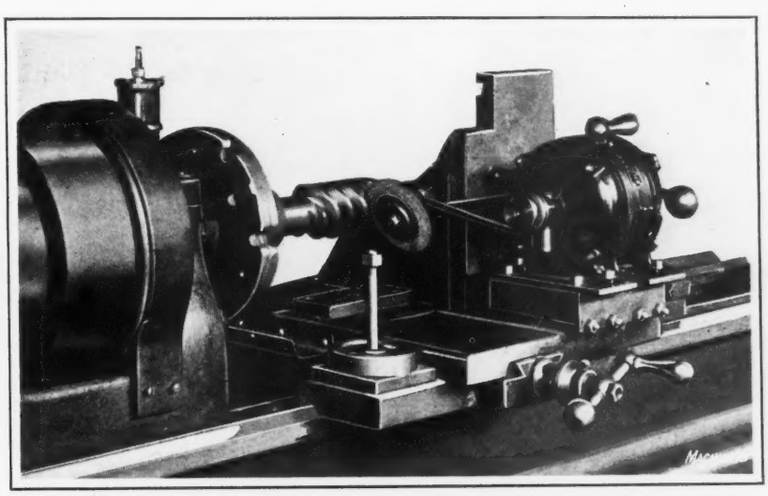


Fig. 1. Lathe Set-up for grinding a Triple-thread Worm

The quantity of pieces to be handled did not warrant the investment in a modern worm-grinding machine; hence it became necessary to equip a standard machine of some kind for the job, so that it would give sufficiently accurate results and a good production rate. An engine lathe was rebuilt for this purpose at our factory in Worcester, Mass.

Later, a similar engine lathe, which is described in this article, was rebuilt at our Detroit plant, incorporating the basic principles of the first machine and adding certain refinements to assist in the operation. A second-hand 12-inch Reed engine lathe, purchased at a reasonable figure, was used, and the feed-shaft, lead-screw, and apron were removed. A master worm, cut on the same machine as the worm to be ground, but about 3 inches longer, was made. This worm was not hardened, so that the inaccuracies, which were to be overcome by grinding, did not appear in it. A nut was formed to fit the master worm by placing the worm in a suitable casting having a hole in it somewhat larger than the outside diameter of the worm, and then pouring babbitt around the worm. The nut thus formed was fastened to the under side of the carriage, and the master worm was held in bearings in the center of the bed of the lathe. The bearings for holding the master worm were so arranged that the worm could be replaced by another, if it were desired to grind a worm of different design. The master worm is driven by a shaft extending through the end of the lathe bed, and geared to the head through the feed gears, with a 1 to 1 ratio, as shown in Fig. 2. In this way, the carriage is given the proper rate of travel relative to the rotation of the work.

The worm that is to be ground is supported between the lathe centers and driven by a pot chuck. This chuck also forms an indexing fixture, so that the three threads will be ground in the correct relation to each other. The general arrangement of the master worm, driving gears, and the method of holding the work is shown in Fig. 2.

An internal grinder spindle, driven by a ¼-horsepower motor, is mounted on a suitable bracket, attached by a dovetail to the lathe carriage, as shown in Fig. 1. A feed-screw, parallel to the bed of the lathe, permits adjustment of the wheel against the side of the worm thread. The grinding

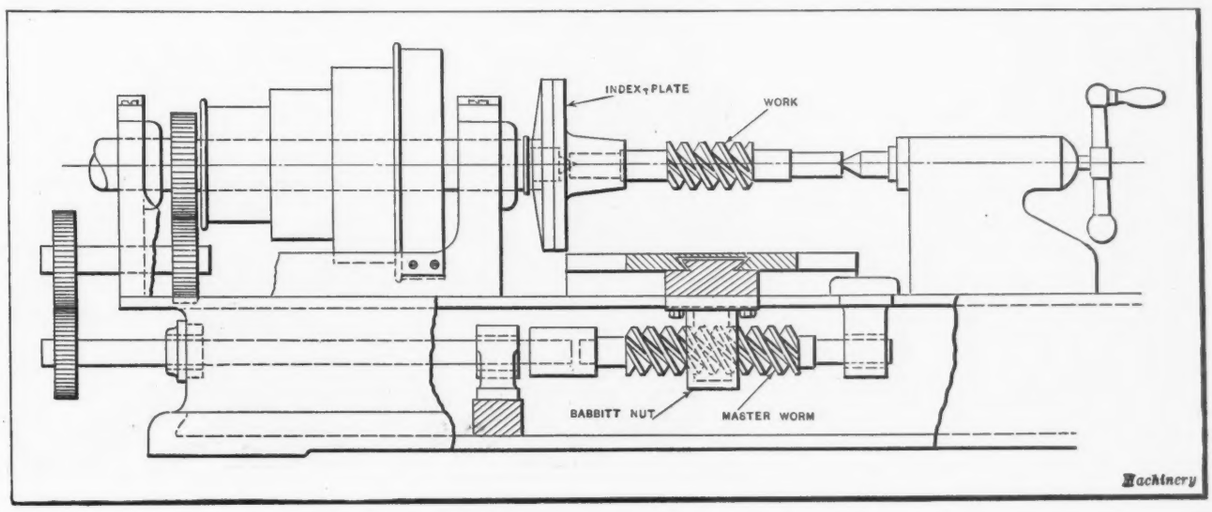


Fig. 2. Diagram showing Master Screw used in Set-up shown in Fig. 1

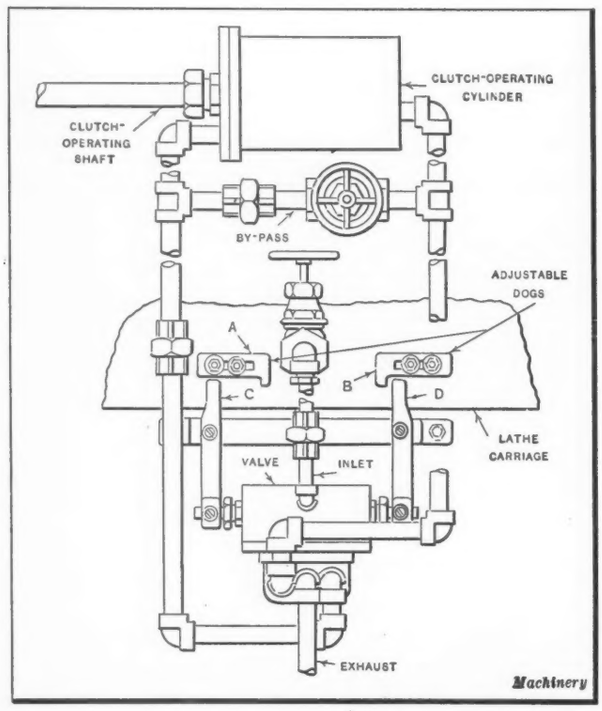


Fig. 3. Air-operated Carriage-reversing Equipment used in grinding the Worm

wheel-spindle, being mounted on a swivel, allows the wheel to be adjusted to the proper lead angle. The original cross-feed screw adjusts the grinding wheel for the depth of the tooth. A fixture is attached to the carriage for guiding the diamond used to dress the wheel to the proper tooth angle. The countershaft, of the usual design, has two driving pulleys engaged by a clutch-type shifter, which provides means for reversing the machine. Pulleys of different diameters are used on the lineshaft to provide a slow feed and a quick return.

Pneumatic Carriage-reversing Device

Referring to Fig. 1, it will be seen that the diameter at the root of the thread is smaller than the bearing surface at the end of the thread. For this reason, the machine must be started, stopped, and reversed within very narrow limits. It can be readily understood that this requires skillful operation and close attention to the work to prevent over-running and breaking of the grinding wheels. To overcome this difficulty, a pneumatic shifting device was developed, the arrangement of which is shown in Fig. 3.

Adjustable dogs *A* and *B*, attached to the lathe carriage, engage levers *C* and *D* at opposite ends of the carriage travel. These levers operate an air valve which admits air to the clutch-operating cylinder. The piston in this cylinder actuates the clutch-operating shaft, thereby engaging and disengaging the clutches on the countershaft. In this way, the direction of rotation of the work and the travel of the carriage are reversed at definite points. A by-pass valve between the two air supply pipes of the clutch-operating cylinder provides a means for equalizing the pressure in both ends of the cylinder, so that the operator can work the shifter lever by hand, to the neutral position or into either engaged position. The by-pass valve may also be used to cut down the effective working pressure of the air, so as to make the clutch work slower, and therefore with less noise.

Operation of the Machine

In operating the machine, only one side of the thread is ground at a time. The operator adjusts the cross-feed to bring the wheel to the required depth, and the wheel is then adjusted against the face of the thread, and fed in by hand until the thread is properly finished. The backlash of the gears driving the master worm is sufficient to provide clearance between the grinding wheel and the work on the return stroke. After each thread is finished, the work is indexed by means of the indexing chuck. The three threads are finished on one side, the work then being reversed and the other sides of the threads ground. The total time for grinding the worm described is forty-five minutes. The same operator that attends the worm-cutting machine handles the worm-grinding, so that no additional labor is required. The finish compares favorably with that obtained with an expensive worm-grinder, and the work is ground within sufficiently accurate limits. The comparatively small cost of rebuilding the lathe, the ease of operation, and the accuracy with which the work is done make this the most interesting job the writer has seen done on a bench or engine lathe.

PRECISION FORM-TURNING

By O. S. MARSHALL

The recoil mechanism of the French (Schneider model) 240-millimeter howitzer was designed with a throttling rod, operating on the hydro-pneumatic principle, with glycerine as the fluid. This howitzer was the largest field piece, not requiring a fixed mounting, that was used in the World War. The throttling mechanism represented a comparatively new principle in ordnance construction, and the successful action of the weapon depended largely upon the efficiency of this part of the outfit, the throttling rod being the vital member.

The Watertown Arsenal had a contract for building the entire recoil mechanisms for howitzers of this kind, and it sublet the contract for manufacturing the interior parts to the Jones & Lamson Machine Co., Springfield, Vt., who designed the special equipment described in this article for turning the throttling rod. A working drawing of the throttling rod is shown in Fig. 3. Attention is called to the diameter dimensions given along the formed part; these are placed along the length of the rod at varying distances from the shoulder at *A*.

The rods were made from rough forgings which required the removal of an unusually large amount of stock; this was accomplished partly on engine lathes and partly on a special long-bed Hartness flat turret lathe. The flat turret

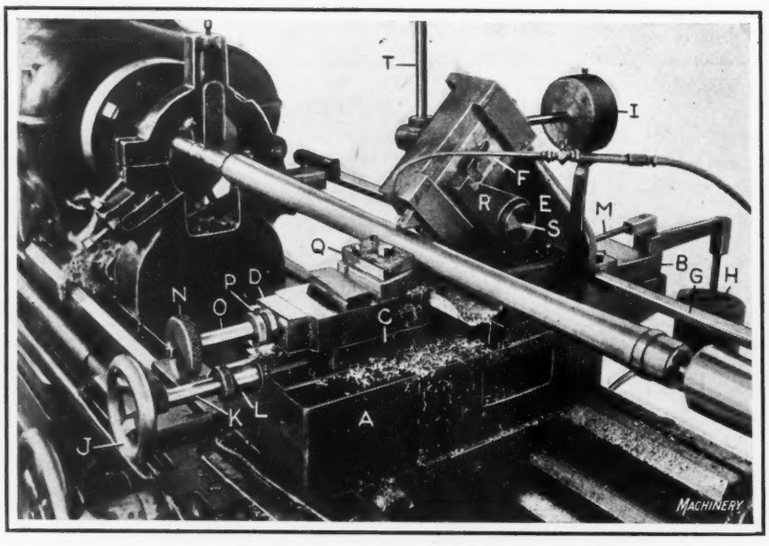


Fig. 1. Front View of Lathe equipped for Precision Form-turning

lathe was used to rough-form the rod previous to the last roughing and final finishing operations on the specially equipped Lodge & Shipley lathe shown in Figs. 1 and 2. This is a motor-driven geared-head lathe, having a 24-inch swing and an 8-foot bed. The regular tool-slide was removed and replaced by the special fixture shown.

Controlling the Follow-rest and Turning Tool

This fixture consists primarily of a base *A*, Figs. 1, 2, and 4, with three movable slides, *B*, *C*, and *D;* a housing *E*, with the follow-rest *F;* and a form-bar *G*. When the lathe is in operation, the weight *H* serves to hold slide *C* in contact with form-bar *G*, so that the path followed by the turning tool will correspond with the form or profile of the front side of the form-bar. The lower end of bellcrank lever *R* on stud *S* is held in contact with a block *Z* on slide *C* (see Fig. 4) by the weight *I*, which keeps the block *Y* on slide *F* in contact with the upper end of lever *R*. This arrangement causes the slide, or follow-rest, *F* to move in and out simultaneously with the turning tool as the latter follows the path determined by the contour of the form-bar *G*.

All the slides have the familiar form of dovetail bearing, with gib adjustment. No pressure is exerted on the gib-screws, however, other than that required to keep them in place. The follow-rest has flat, rectangular bearing surfaces, also with gib adjustment. The fixture was so positioned on the lathe that the horizontal and vertical faces of follow-rest *F* would bear with equal pressure on the work. The housing *E* which supports the follow-rest mechanism was securely bolted to the base *A*, and this was made stationary on the lathe carriage when it was in the proper position.

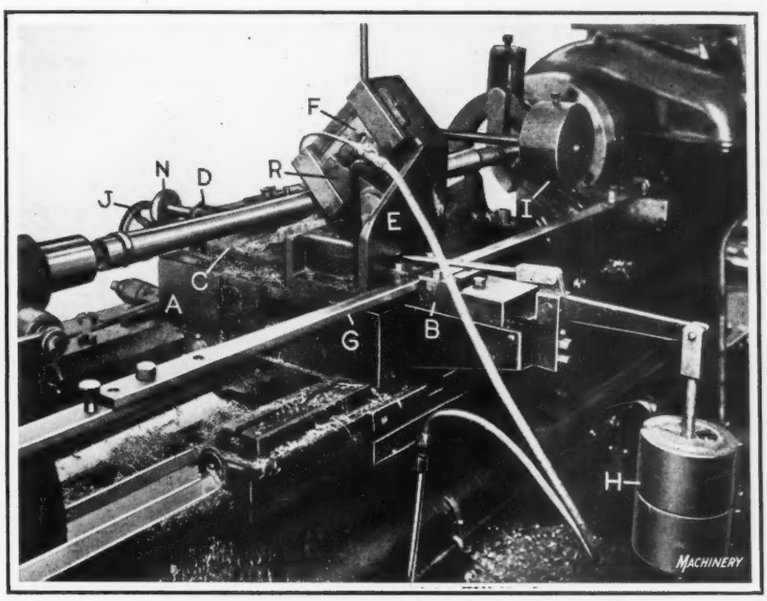


Fig. 2. Rear View of Precision Form-turning Lathe Equipment

Method of Mounting Form-bar

The form-bar *G* is securely bolted to the lathe, with its rear edge, which is straight, located parallel with the lathe centers, care being taken to have the centers accurately lined up with the ways. The form-bar is also set at the proper height so that it will have lateral support on the slide *B*. This slide is adjustable from the front side of the lathe by means of the handwheel *J*, secured to shaft *K* which reaches through and connects with slide *B* by means of a lead-screw and nut. Slide *B* is adjusted crosswise so that it will support the back side of the form bar in a perfectly straight line with its two end supports. A graduated collar reading to thousandths of an inch registers the adjustment as it is made. This slide is not moved except to compensate for the slight wear in the hardened and ground contact points *a* and *b*, Fig. 5, which bear against the form-bar. The support for the rear end of the form-bar is shown in Fig. 6. It will be noted that this support is provided with means for making longitudinal as well as transverse adjustments.

Slide *C*, Fig. 4, is kept in contact with the form-bar by the weight *H*, which has a lever connection with the slide through the link *M*. Consequently, it has no movement except that imparted by the form-bar as the lathe carriage travels along its ways. The tool-slide *D* moves only as slide *C* moves. It may be adjusted as required for tool-setting by the handwheel *N* secured to the cross-feed screw *O*. A graduated dial *P*, reading to thousandths of an inch, is provided for shaft *O*. The tool pocket is carefully machined to receive a cutter *c*, which is ground all over. The cutter is securely held in place by the rigid clamping block *Q*.

The follow-rest *F* is inclined at an angle of 45 degrees with the horizontal, and is controlled in its movement by the lever *R*, as previously described. The contact blocks *W* and *X* on lever *R* are hardened steel, as are also the blocks *Y* and *Z*. The block *Y* may be adjusted lengthwise in relation to the follow-rest *F* by means of the abutment screw *V*, after which it is secured in place by the clamping screw *U*. The separate bearing shoes *d* and *e* are made of high-speed steel and are carefully hardened and ground. The relative lengths of the arms of lever *R* are such that the proper movement of the follow-rest is insured along every part of the work, adequate pressure being exerted upon it by the weight *I* through the leverage which forces it against the upper arm of lever *R*. The lever *T* is for raising the follow-rest by hand when changing work.

The form-bar *G* was the most difficult part of the outfit to make. It was considered necessary to make this of tool steel to withstand the long and severe usage to which it was to be subjected. One bar was made of this material, but it assumed irregularities after hardening and resisted all efforts to straighten. Two more bars were made of a good grade of machine steel, given a deep carburizing treatment, hardened and polished, after which they were readily straightened.

The form-bar had to be very accurate, as the work was required to be held within limits of minus 0 and plus 0.002 inch at every point of the formed portion. After the bar was planed, it was put on a large miller which was in first-class shape and secured to the platen with the edge to be formed uppermost. A ¾-inch end-mill was used for the cutter. An indicator was attached to the over-arm support with its contact point in line with the axis of the cutter-spindle, and low enough to bear upon the platen of the miller when the cutter was at work. With the horizontal table feed engaged for lengthwise motion, the operator manipulated the up and down movement of the vertical feed by hand, gaging his depth by the indicator in accordance with the profile supplied him by the engineering department. This method worked wholly satisfactorily, and a little hand work completed the bars ready for hardening.

Method of Inspecting Work

The inspecting device shown in Fig. 7 was the next most difficult thing to make. It consisted of seventeen Ames indicators, with specially made hardened and ground contact points. The indicators were held on individual supports shaped like a letter E with the central projection of the E cut away. Each indicator had a mating contact point, the

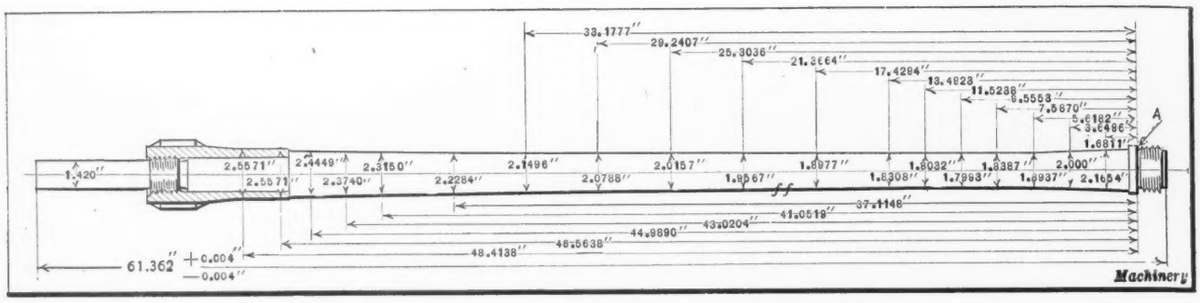


Fig. 3. Throttling Rod machined on Lathe shown in Figs. 1 and 2

arrangement serving as an indicator-caliper which showed the size of the work at the various points.

These indicators were mounted on a substantial bar in slots which controlled their movements to a nicety and at intervals corresponding to the dimensions supplied on the drawing. Yokes were provided at each end of the indicator supporting bar to receive and support the rod being tested. The yoke *A* shown at the left in Fig. 7 serves also as the

throttling rod when the latter was held in position for turning.

The material from which the throttling rods were made was 60-point chrome-nickel steel. This, together with the fact that they were crudely hammered out under a trip-hammer, made them highly satisfactory as buffers against sudden shock but correspondingly difficult to machine. The contact shoes of the follow-rest were made up in quantities.

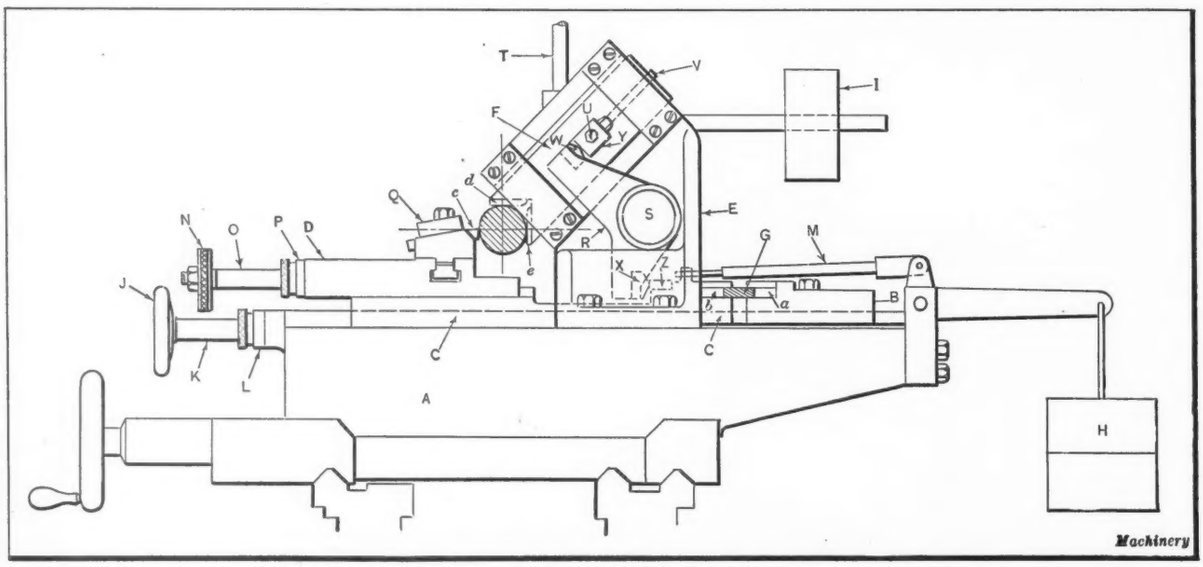


Fig. 4. Detailed View of Precision Form-turning Attachment

definite end-locating stop from which the linear distances are taken. This testing fixture was set in a suitable box *B*, placed on a bench conveniently located for the lathe operator. As soon as a rod was completed, it was inspected and passed upon by the official inspector. A master bar was used frequently, in order to make sure that the indicators maintained their proper setting. The form-bar was so positioned on the lathe that its contour registered with the

The worn shoes were used for roughing while the new ones were used for finishing cuts. The turning tools also were made up in advance, from a bar from which satisfactory trial tools had been made. The cutting point was located in a plane horizontal with the axis of the work, and the point of the tool was ground with a radius of about 1/16 inch. The shoes of the follow-rest were ground with the same radius and were made to bear just behind the chip.

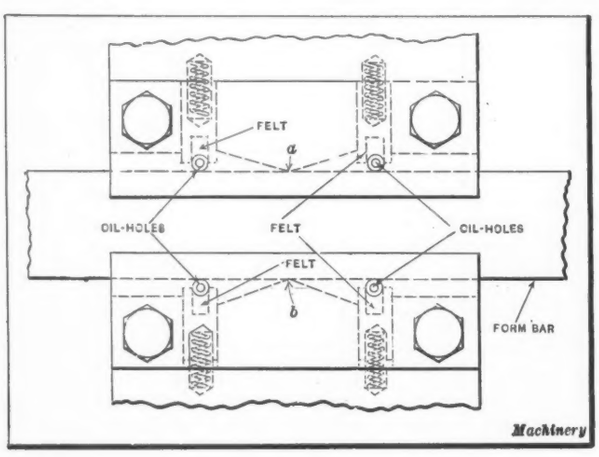


Fig. 5. Form-bar Guide Bearings

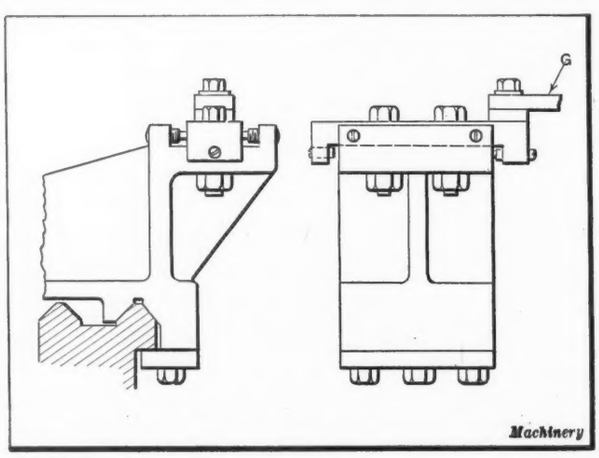


Fig. 6. Rear Support for Form-bar

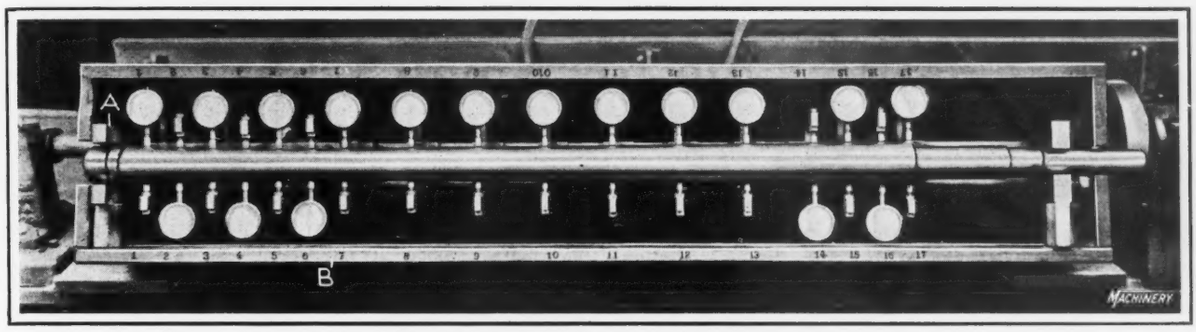


Fig. 7. Fixture used for testing Accuracy of Formed Throttling Rod

An oil cutting compound was used. This prevented water from getting into the vital moving parts, as would be the case if water-mixed compounds were used. Two or three cuts were taken in finishing a rod with this equipment, the average time being three hours and twenty minutes for one rod. Special care was taken to have the lathe centers in good condition and accurately located. The work was driven from the end opposite the one from which the linear dimensions are given. This made it necessary to have the depth of the center in the driving end of the work accurate with respect to the shoulder from which all the dimensions for the formed part were given.

In conclusion, it should be said that the original routing of the throttling rods included finishing the formed part by grinding. A special grinding fixture was partly drawn up, but it was finally decided that it would be best to depend on obtaining the required excellence of finish by applying the old-fashioned method of "doing a good lathe job." The rods were turned to within one or two thousandths of the largest tolerance, then brushed with a smooth shafting file and polished with fine emery cloth. The work thus produced was perfectly satisfactory to the official inspector. Over 300 throttling rods were turned without a single loss. The excellent mechanical design of the fixture and the painstaking work in its manufacture were responsible for the satisfactory results obtained.

* * *

POSITIONING DETAILS ON DRAWINGS

By EDWARD HELLER

The method of detailing machine parts or tools here described has some features that may be of interest to MACHINERY's readers. With the exception of large assemblies or lay-outs, all drawings are made on sheets 18 by 24 inches in size. When a full-size drawing of a part would be too large for a sheet of this size, it is drawn to a smaller scale, while for small details the sheet is blocked out as shown in Fig. 1. Each block contains all the information necessary to identify the detail with the sheet it is on and the machine or other part it is used for.

When a blueprint comes to the shop and the foreman wishes to let different men make the details, he simply cuts the print up in as many parts as necessary and hands each man the print of the part he is to work on. As each piece of the blueprint contains information that connects it with the drawing as a whole, it can always be identified. In the drafting-room the sheet can also be divided into two or three parts. In the latter case, one detail would be on a half of the sheet bounded by lines AA or BB, and the other two details would each be on one of the remaining two sections. In either case no division is made smaller than a quarter of a sheet. The method just described is used on production drawings only.

On tool drawings the divisions are not made to any particular pattern, but to suit the details. Fig. 2 shows an arrangement of a sheet with one detail drawn in the upper right-hand corner section. The parts of the tool are numbered on the assembly drawing from 1 up, and the tool as a whole is given a number such as TB-109, as shown in the lower right-hand corner. Each block contains the tool number together with the detail number. In the case of the detail shown in the upper right-hand corner of Fig. 2, the number TB-109-7, identifies this block with the others on the drawing. As in the case of production drawings, advantage is taken in the shop of the divisions on the drawing. The sheet is cut up, and as many men can be put on the job as there are details.

The advantages in filing the tracings are obvious. With very few exceptions, all tracings of one kind are kept in one file and can be easily found. When a machine or tool is designed in which a part of another machine or tool is used, the part is called for on the assembly, but no new drawing is required. A blueprint of the section of the tracing on which the part in question is detailed is made and sent to the shop with the rest of the blueprints for the job.

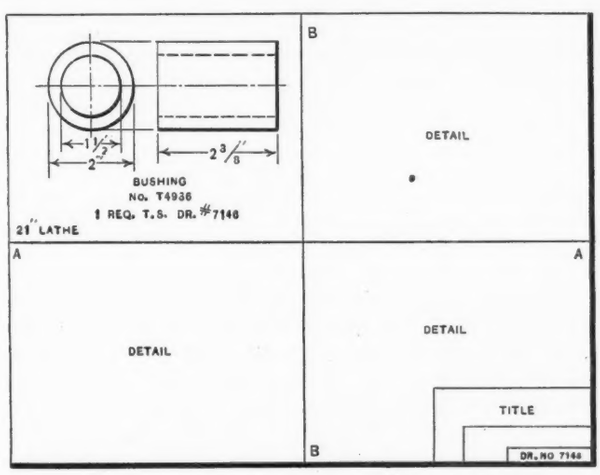


Fig. 1. Method of dividing Detail Sheet into Sections or Blocks

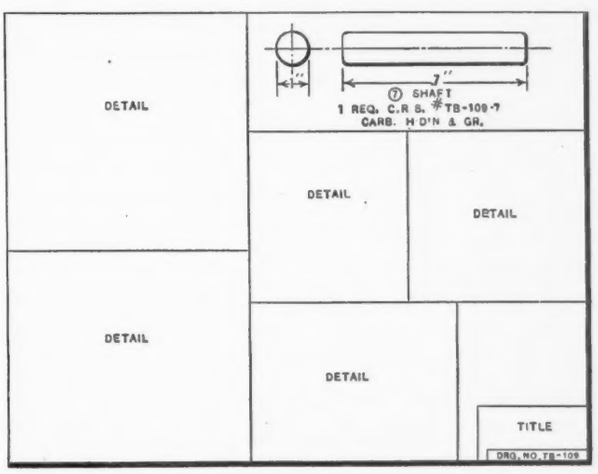


Fig. 2. Typical Detail Sheet used for Tool-room

Follow-die for Small Clips

By EDWARD HELLER

THE follow-die shown in Fig. 1 is employed to produce clips like the one shown at *A*, Fig. 2. By making slight changes, it can also be used to produce clips like the one shown at *B*. The general design of the die is such as to make it readily adaptable for a variety of work. There are six distinct steps in making either of the pieces shown in Fig. 2. After the sixth stroke of the press, two complete clips are made at each stroke, one clip being cut from each side of the strip stock. The appearance of the end of the stock after the first two clips have been cut off is shown by the view in the lower right-hand corner of Fig. 3.

Fig. 2, which is the form given the first pair of clips at the succeeding stroke of the press. At the fifth stroke the formed ends are cut off by the tools *J* and *K*, shown in section *B–B*, Fig. 1, while the two ends *J*, Fig. 3, are formed by the die *S* shown in sections *A–A* and *C–C*, Fig. 1. At the sixth stroke of the press the completed clips are sheared off so that the strip stock appears as shown in the lower right-hand corner of Fig. 3.

In each succeeding stroke of the press one pair of clips is cut off and allowed to drop through the openings in the die. When the right-hand end of the strip stock passes the

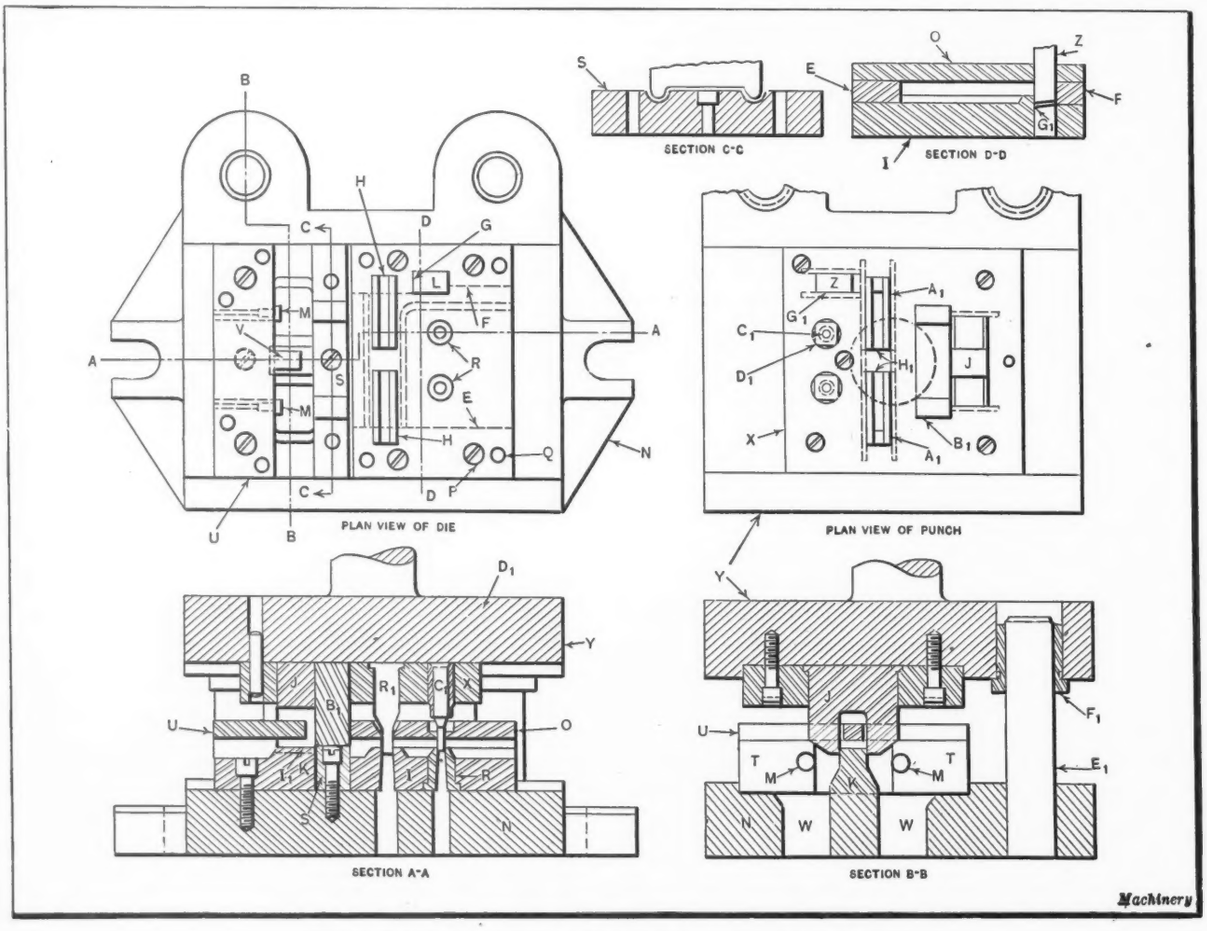


Fig. 1. Follow-die designed to produce Clips of the Type shown in Fig. 2

The stock is fed in between the guides *E* and *F*, Fig. 1, and is stopped or located in position by the step *G* in guide *F*. Then the press is tripped and the notch *A* and holes *B* shown in Fig. 3 are punched out. The notch will now permit the strip to be moved in another space so that edge *C* is in contact with the step *G*, Fig. 1. At the second stroke of the press, the notch is continued, as shown at *D*, Fig. 3, and two more holes are pierced at *E*. When the strip is moved in for the third time, the extreme end of the stock is located over the openings *H* in the die-block shown in the plan view of the die in Fig. 1. In the third step, the slots *F* are punched in the stock, as shown in Fig. 3.

At the fourth stroke of the press the end of the strip lies over the forming dies which are shown in section *C–C*, Fig. 1. The narrow strips *G*, Fig. 3, which must be discarded as scrap stock are formed to the shape shown at *A*.

opening *L*, shown in the plan view of the die, Fig. 1, the stopping or locating of the stock is accomplished by the two buttons or studs *M* shown also in section *B–B*.

After the strip stock has been passed through the die, the notched strip shown at *K*, Fig. 3, is left as scrap. However, this strip of metal is used in making other parts so that it cannot be really considered as scrap. Although the various views in Fig. 1 show the construction of the die quite clearly, there are some features that it may be well to explain somewhat in detail. The die-block *I*, the guides *E* and *F*, and the stripper *O* are all fastened to the cast-iron die-shoe *N*. The screws *P* and dowels *Q* extend through the stripper guides and guide block into the die-shoe. Die-block *I* also carries the two piercing dies *R*. It is evident that replacements can be readily made in dies of this construction.

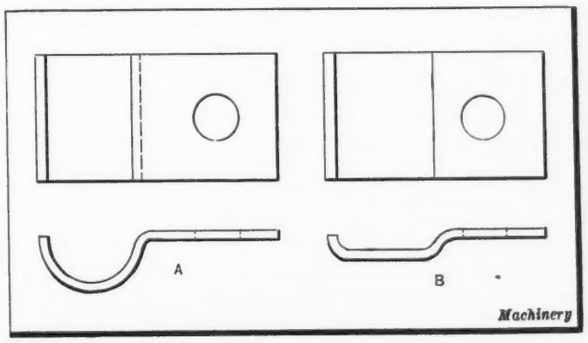


Fig. 2. Clips made from Strip Stock

The forming die *S* is held against the die-block *I*, and next to it is located the cutting-off die *K*. This cutting-off die is T-shaped, and the cutting-off punch straddles the part that would ordinarily be the vertical section of the "T." The space in the recess of the die-shoe is filled with cold-rolled steel fillers *T*. These fillers carry the stop-studs *M*. Over the die *K* is fastened the end stripper *U* which has a tooth *V* on it. When the strip of stock reaches the cutting-off die, it slides under this tooth, which effectively strips the scrap piece from the punch *J*. The finished clips fall through the holes or openings *W* in the die, as shown in section *B–B*.

All the punches are carried in the punch-plate *X*, and this plate is fastened to the punch-holder *Y*. The stop-punch *Z*, (shown in the plan view of the punch and in section *D–D*), the notching punches A_1, and the cutting-off punch *J* are all fitted to the punch-plate, and are prevented from becoming loose or falling out by flanges at their head ends which fit into recesses in the punch-plate. The forming punch B_1 is also located in a rectangular hole in the punch-plate *X*, but is secured to the punch-holder by means of fillister-head screws. This construction makes it possible to remove the forming punch and grind it on the top end when the sharp edged tools are ground down. Forming die *S* is also attached to its holder in the same manner. When the lower cutting tools are sharpened, this die is taken out and ground on the bottom. Thus the proper relation is maintained between the height of the different units. The piercing punches C_1 are secured in independent threaded punch-holders that have square ends. With this type of holder, a broken piercing punch can be replaced without removing the punch-holder from the press ram. The punch and the die units are kept in alignment by means of the guide pins E_1 and bushings F_1.

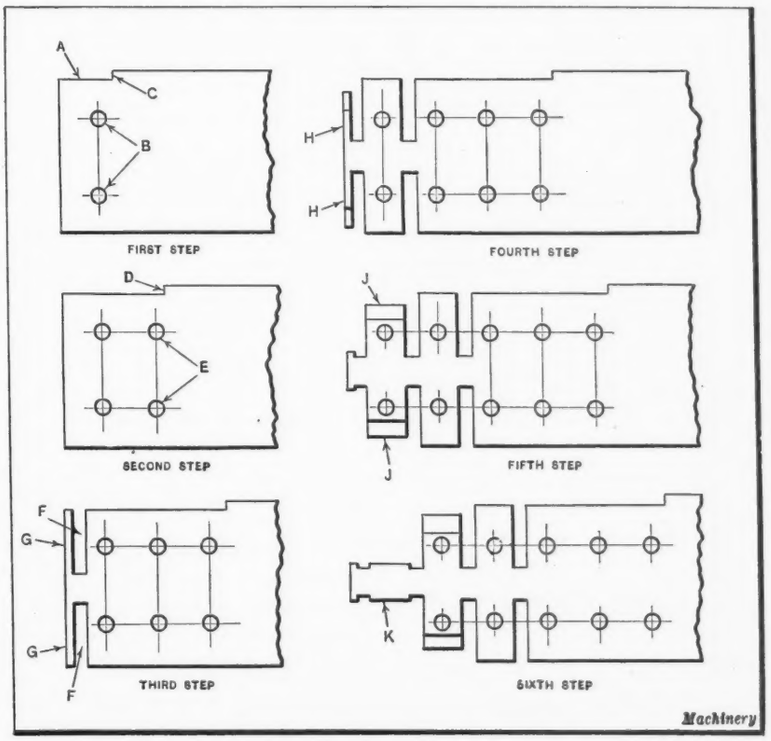


Fig. 3. Consecutive Steps in the Production of Clip shown at A, Fig. 2

Adapting the Die for Different Types of Clips

The type of die described in this article, as before mentioned, can be used for a variety of work by making slight changes in its construction. The important changes necessary in the production of two different parts will now be described. The clip shown in full lines in the enlarged view at *D*, Fig. 5, is laid out for the production of two pieces at a time, the stock being formed and cut off as indicated by the dotted lines at *E* and *F*.

The most difficult problem in producing this piece was the designing of a suitable cutting-off punch, as the outside width of the punch was limited by the upward protecting ends of the clips *D* and *F*. If the cutting-off punch were cut away deep enough or high enough to straddle a stripper tooth, such as shown at *V* in Fig. 1, the channel section of the punch would be very weak at that point. In order to overcome this difficulty, the tooth *V* was eliminated and a spring plunger *B* and spring *C*, as shown in Fig. 5, were employed to take its place. It will be noted that the die *A* is so shaped that the upward protecting ends of the stock are located on each side of the punch. The plunger *B* was really required only for the first cutting-off stroke, as the scrap web *G*, Fig. 3, rests under the body of stripper *U*, Fig. 1, after the first cutting-off stroke.

The hook-shaped clip shown at *A*, Fig. 4, is another example of the kind of work produced on the type of die shown in Fig. 1. This hook is made of rather heavy gage stock. There seemed to be some doubt at first as to whether the long slender ends *B* of the forming punch would stand up well, and for this reason the punch was made in two pieces, so that if one end became broken it would only be necessary to replace the broken end. In dies of the kind described, it is very important that the various punching or cutting units have the proper amount of shear. This lessens the strain on the press and tends to eliminate distortion in the tool itself.

Referring to Fig. 1 the piercing punches C_1 are ground chisel-shaped. The stop-punch *Z* is ground so that the point G_1 (shown in section *D–D* Fig. 1) strikes the metal first. This punch is backed up by the guide *F*, which is made of tool steel and hardened, and comes in contact with the guide before it begins cutting. The notching punches A_1, shown in the plan view of the punch, are ground hollow in such a manner that the points H_1 strike the work first, then the

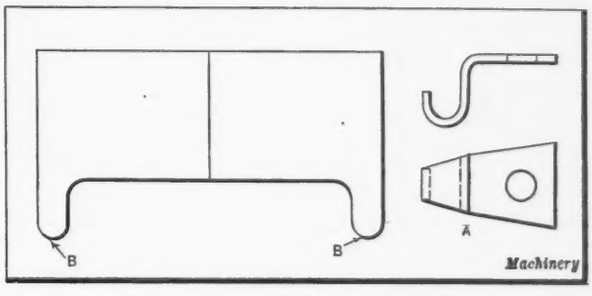


Fig. 4. Two-piece Forming Punch for Clip A

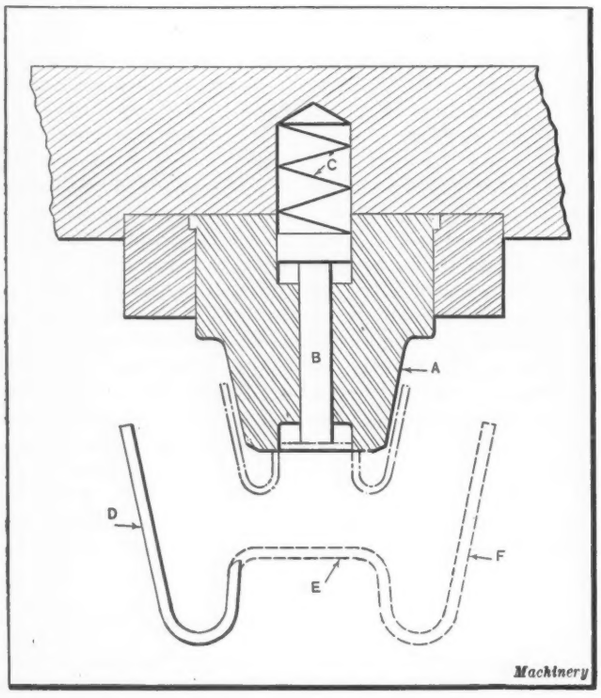


Fig. 5. Cutting-off Punch of Unusual Design

outside edges, and finally the middle of the punches comes in contact with the work and completes the notching operation. These punches also have pilot ends that enter the die at the sides of the strip stock. The pilots are well entered in the die before the punches begin to cut.

The slugs that come from the notches cut in the stock are curved or V-shaped. The cutting-off die *K* is ground so that the high spot is at I_1 (see section *A–A*). With the exception of the last-named die, the shear can be made from 1 to 1½ times the thickness of the metal. In the case of die *K*, the shear should be very slight, as otherwise it will deform the web *G*, Fig. 3, and make it difficult to feed the stock under the stripper *U*, Fig. 1.

* * *

CAN YOU BOSS YOURSELF?

When struggling up the business ladder in an effort to become a boss yourself in the shop where you work, don't forget that in order to qualify you must have learned how to boss yourself. Do you recall the "Message to Garcia"? Sifted down, it means that a really capable fellow needs very little bossing. He does the things wanted without supervision; high-priced men generally require little supervision.

You don't have to be a boss over others in order to start learning how to boss yourself. Take yourself in hand; be your own boss; supervise and criticize your own work; be your own timekeeper; analyze your own progress; think of new ideas for yourself; try to think of a better method of handling or systematizing your duties. Study how to become the efficiency engineer of your own job. No boss can boss you half so efficiently as you can yourself.—*National Lock News*

* * *

The belief that most accidents are due to dangerous machinery used in the industries is one of the greatest fallacies by which those concerned with the welfare of workers are misled. In 1922, only a little over 4 per cent of all fatal accidents were due to industrial machinery. Automobile accidents accounted for 18 per cent; accidental falls for 17 per cent; and railroad accidents for 9 per cent. Drowning alone caused more than twice as many deaths as machine accidents in the industries.

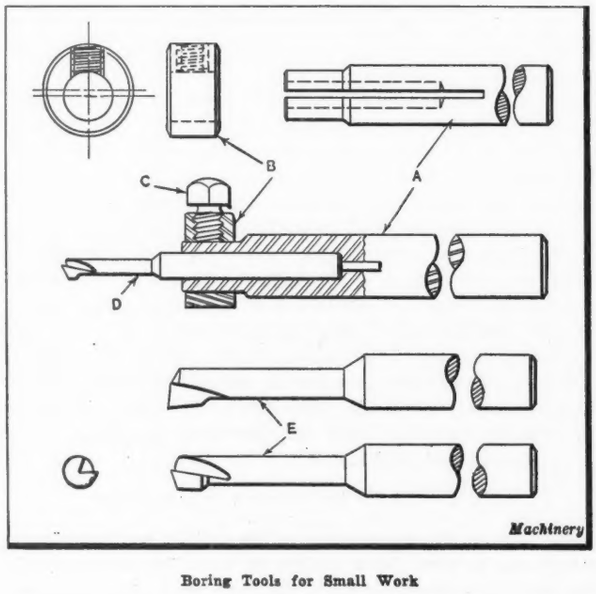
TOOLS FOR BORING SMALL WORK IN THE LATHE

By ERNEST L. HOLCOMB

The writer has found that boring tools of the design here illustrated can be used to advantage on small lathe work that requires the boring of accurate holes. One of the tools shown consists of a holder *A*, clamping collar *B*, set-screw *C*, and boring tool *D*. It is desirable to have a set of boring tools like the one shown at *D* with points of different sizes but with shanks that fit the holder *A*. The principal feature, however, is the design of the cutter lip. The same design of lip is suitable for larger tools like the one shown at *E*, which is held in the regular boring tool holder or V-block without any separate holder or adapter *A*. The shape of the cutting lip can be seen more clearly by referring to the boring tool *E*.

The tool-holder *A* is made of 7/16-inch round tool steel or drill rod, with one end turned, drilled, reamed, slotted, and spring-tempered. The slot at the front end of the holder may be made with a hacksaw. It is well to spread the slotted end slightly before hardening and tempering so that the clamping collar *B* will be held in place even when the set-screw is loosened. Collar *B* is made of 11/16-inch round cold-rolled steel, the hole through the ring being offset about 3/64 inch. The set-screw *C* fits the ¼-inch hole tapped in the collar. It may be well to mention here that collar *B* is cyanide-hardened. The boring tool *D* is made from 3/16-inch drill rod, the neck being turned down with a round-nosed tool, leaving a section at one end ⅛ inch long, which is somewhat larger than the neck. After performing the turning operation, the tool is clamped in a bench vise and a notch filed diagonally across one side of the large section at the end to provide a cutting edge having a top rake, and to give sufficient chip room.

The clearance for the cutting edge at the front end of the tool is ground free-hand on a small grinding wheel with the center line of the tool held on a line with the right-hand side of the grinding wheel, the tool being turned or revolved slowly during the grinding operation in such a manner as to develop a spiral surface on the front end. Side clearance for the cutting edge is obtained by grinding or filing the end of the tool so that it is eccentric with respect to the necked portion as indicated by the end view in the lower left-hand corner of the illustration. The rake and clearance angles are about the same as those usually employed for boring tools. After the tool has been hardened and tempered, the cutting edges are smoothed up with an oilstone. To resharpen a tool, it is only necessary to stone or grind the top surface of the lip.



Boring Tools for Small Work

Conical Clutch Designs

By ALBERT CLEGG

CONICAL clutches have two great advantages over expanding or contracting ring clutches in that there is an absolute certainty of disengagement and a more definite assurance that the pressure between the friction surfaces is equally distributed. Fig. 1 shows a conical clutch designed by the writer to transmit about 8 horsepower at 400 revolutions per minute, for effecting the reverse motion of a radial drilling machine. The large diameter of the cone is 4⅜ inches, and the face width, 1 inch. The drive is from two bevel gears to shaft *A*, which is connected to the spindle through back-gears.

Construction of a Conical Clutch for a Radial Drilling Machine

Keyed to shaft *A*, but free to slide on it, is the clutch body *B*, which has a solid flange at the right-hand end to form the friction surface, and a flange *D* screwed on the left-hand end, for the other friction. Fitting into longitudinal grooves in the body of the clutch and pivoting on transverse pins *E* are two bellcrank levers *C* having a projection *F* which fits into an annular groove turned in shaft *A*. The fit is sufficiently loose to permit levers *C* to be swung a certain amount. The outer ends of levers *C* are bent upward to project well above body *B;* sliding on the latter, and keyed to it, is the shipper *G*. The ends of the shipper are rounded where they come in contact with levers *C*. In engaging the left-hand friction surfaces, the shipper is pushed to the left, causing levers *C* to swing slightly and, due to the contact between the levers and the groove in the shaft, body *B* is forced toward the left.

On the extreme left-hand end of shaft *A*, there is an adjusting nut *L* provided with a lock-screw *M* and a brass pad. Adjoining the adjusting nut is a washer *K*, which is feathered to the driving shaft and fits against a second washer *J*, pinned to the hub of the miter gear. The purpose of washer *J* is simply to increase the diameter of the thrust face for washer *K*, and as the latter is keyed to the shaft, it prevents loosening or tightening of the adjusting nut, which would upset the adjustment.

To adjust the clutch, lock-screw *M* is loosened, and nut *L* advanced very slightly, the pressure meanwhile being tested by the "pull" of the operating handle. When the desired adjustment has been obtained, the lock-screw is retightened, after which the clutch is ready for use. The whole operation does not consume much more time than a minute.

Several clutches of this type which have been in use for four or five years are apparently as good as the day they were made, because the tool marks are still visible on the friction surfaces. Considering the power transmitted, the comparatively low speed, and the fact that the clutches are used every time the machine spindles are started and stopped—probably two hundred times a day—the small amount of wear indicates a worthy design. The friction surfaces are made of cast iron in each case, and the shipper, levers, and pins are of mild steel and casehardened. Across the friction surfaces were milled twelve grooves *P*. The purpose of these grooves was explained in connection with Fig. 4 in the article on expanding clutches, in June MACHINERY.

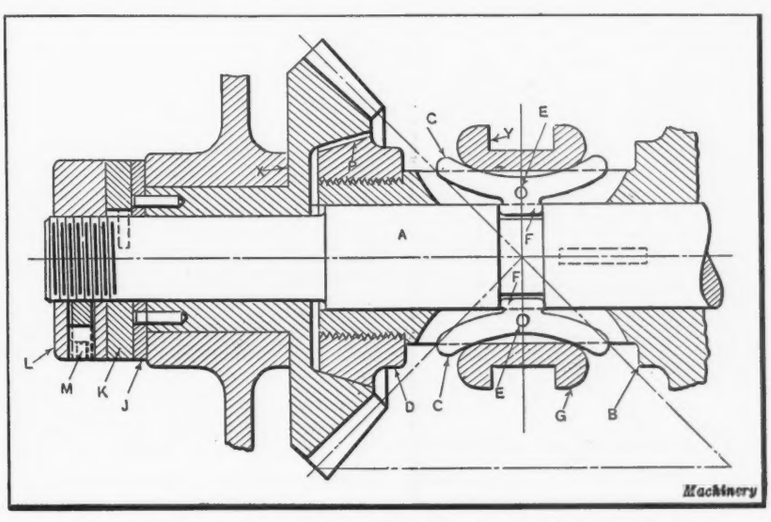


Fig. 1. Conical Clutch of Compact Design used on a Radial Drilling Machine

Principles to be followed in Designing Conical Clutches

There are two principles that should invariably be followed in conical clutch design: First, the friction surfaces should be of equal length, and second, the closing pressure should be obtained entirely by means of the clutch and its component parts; in other words, it should be self-contained. The first point is illustrated by the diagrams *A* and *B*, Fig. 2. Diagram *A* shows two conical frictions in which the wearing surfaces are incorrectly fitted, while *B* shows (exaggerated) what happens when wear takes place. Two shoulders are formed at *D* and *E*, and though minute, they seriously affect the operation of the clutch and tend toward an accelerated rate of wear. At *C* is shown the correct method of fitting such parts, the male and female surfaces being equal in length, so that if any wear takes place, the clutch will always maintain practically a full surface contact.

Regarding the desirability of having the closing pressure self contained, it will be seen from Fig. 1, that when the clutch is fully engaged, there is no extra end pressure on any of the bearing faces, the gear and clutch being squeezed together by forces which are practically balanced axially. Suppose, now, the shipper were made solid with the clutch body and the small levers eliminated, the force required to press the frictions together (amounting to several hundred pounds) would have to be applied directly to the shipper by means of the operating handle. This would mean that some multiplying arrangement would have to be provided, but even then, there would be a constant load, developing a large frictional resistance on side *Y* of the shipper, and an equal resistance on face *X* of the miter gear. The braking action of these two resistances would seriously reduce the efficiency of the drive, and the surfaces subjected to the pressure would wear quickly. With the design shown in Fig. 1 there is nothing of this sort to contend with, because apart from the comparatively slight axial pressure developed while the clutch is being engaged, there is no pressure on the faces other than that produced by the gears.

A further advantage of the cone clutch, as compared with the ring type, lies in the greater facilities afforded for substantially increasing the power capacity with little increase in cost and with practically no increase in the overall dimensions of the clutch. With the ring type of clutch, for a given unit bearing pressure on the friction surfaces, the only way that the load-carrying capacity can be increased

is by increasing the diameter or width of the expanding ring. That is to say, there is not much possibility of increasing the area of the wearing surfaces except by increasing the width or diameter.

With the conical clutch, however, it is easy to increase the area to nearly four times that of an ordinary single-surface clutch, and yet the clutch will require little additional space. The idea is shown diagrammatically in Fig. 3. In place of the single pair of friction surfaces, the clutch has four pairs, two at *A* and *B* in the miter gear, and two at *C* and *D* in a flange fixed to the boss of the miter gear. The outer friction *E* is keyed to the driving shaft, but free to slide on it, and is backed up by an adjusting nut *F* which has a lock-screw, as in the previous example.

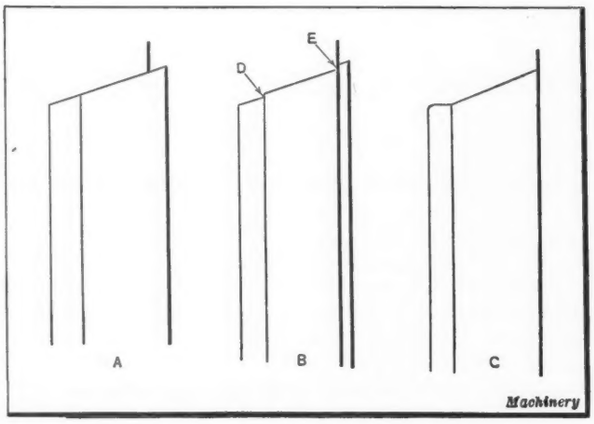


Fig. 2. Diagram showing Wearing Tendencies of Clutches incorrectly designed

The closing mechanism is also similar to that in the previous example, except that to maintain the same unit bearing pressure, it should be capable of developing twice as much axial pressure. At first glance one might assume that the axial pressure ought to be four times as big, since the surface area is in that proportion, but this is unnecessary, because as the axial pressure is balanced when the clutch is engaged, it follows that whatever pressure is developed on the friction surfaces of the miter gear, an equal pressure is exerted on the outer friction *E*. Otherwise there would be unbalanced pressure in one direction with a corresponding extra load on the bearing faces of the miter gear and the shipper. In this design there is a slight movement of the driving shaft to effect the engagement of surfaces *C* and *D*. The multi-cone design of comparatively small radial dimensions lends itself to heavy-duty service, while for durability, owing to the more certain distribution of the pressure and better all-around operation by reason of the positive disengagement, it appears to be far ahead of the expanding ring type of clutch.

Conical Clutch for Lathe Feed Control

A double-cone clutch designed for instantly engaging the feed of a lathe apron in either direction, and disengaging it with equal facility, is shown in Fig. 4. In this design there is no possibility of self-tightening or self-loosening. For extremely heavy duty, there is no reason why the clutch could not be made with four sets of friction surfaces similar to the design shown in Fig. 3, but for most purposes the double clutch will be sufficient, particularly if the diameter and width of the friction surfaces are made as large as circumstances will allow.

The ordinary rules for obtaining the allowable unit bearing pressure for transmission friction clutches are not applicable in the case of feed friction clutches such as that now being considered. The velocity of the friction surfaces on such a clutch is usually so low, and the slipping of one surface on the other so rare, that there need be no fear of allowing pressures even up to 1000 pounds per square inch. If the gripping mechanism is such that ample pressure can be developed between the friction surfaces to enable the clutch to transmit the required load, there is not very much risk of failure resulting from an unduly high unit bearing pressure.

The design illustrated in Fig. 4 is used to couple worm-gear *A* to gear *B* for engaging the automatic feed of the lathe. Gear *B* is, of course, connected to the cross and longitudinal feed gears by sliding or tumbler gears. The worm-gear is keyed to a short shaft *C* which passes transversely through the apron and at the outer end carries a friction clutch *D* which is keyed to the shaft but is free to slide on it. The inside of the worm-gear is machined to form a female friction surface to fit the male friction surface of feed gear *B*, while the latter is similarly machined to receive the friction surface of member *D*.

It will be apparent from the illustration that gear *B*, when coupled to the worm-gear, is clamped between two driving surfaces, that of the worm-gear and that of part *D*, so that whatever axial pressure is applied to part *D*, an equal pressure is applied to the worm-gear friction surface. Consequently, there is almost twice the torque capacity that there would be with a single friction, or, expressed in another way, there is equal capacity with one-half the axial pressure. The large diameter of the cone on gear *B* is 4 inches, and of part *D*, 3½ inches, the height of the cone being ⅝ inch. The cone angle is 15 degrees.

Hand-knob *E*, which screws on the outer end of the apron feed-shaft *C*, is the means whereby the axial pressure is applied. This knob, to be comfortably manipulated by one hand, should not be more than 3 inches in diameter, and

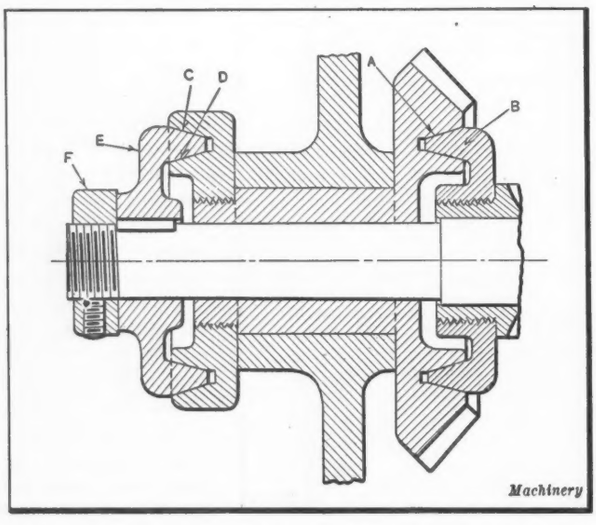


Fig. 3. Clutch with Four Friction Cones intended for Heavy-duty Service

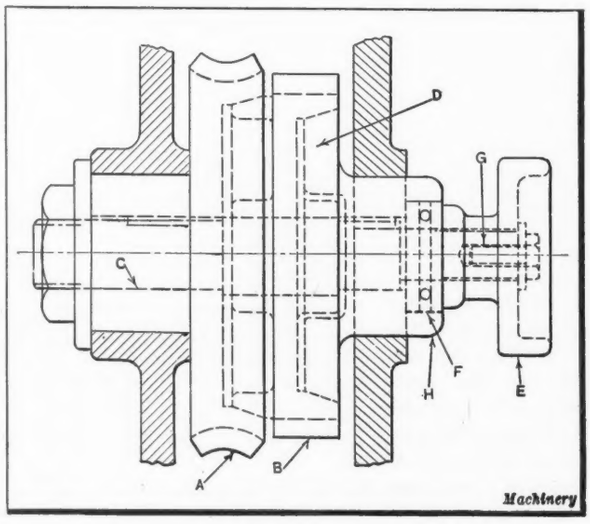


Fig. 4. Double-cone Friction Clutch for engaging the Feed of a Lathe Apron

from ¾ to 1 inch wide on the face, and the face should be knurled or grooved to permit a good grip. To anyone who has not given the matter much thought, it is surprising to find how seriously the friction between the knob and the part it presses against may affect the operation of one of these clutches. This friction ordinarily comprises more than half the turning effort that must be applied to the knob, or in other words, the friction of the collar reduces the axial pressure by more than one-half. Again, the frictional resistance of the thread on which the knob screws is approximately proportional to the diameter of the thread, so that to secure the best results, the diameter of the thread should be as small as is consistent with the necessary strength; ¾ inch is about right.

With the design shown, there is no collar friction, because a ball thrust bearing *F* is provided. The boss of part *D*, which projects from the apron at *H*, is counterbored to receive the ball bearing, and thus protects it from dirt and chips. The small screw *G* is screwed into the end of the feed-shaft to prevent the hand-knob from loosening. Since the sliding member *D* is keyed to the same shaft that the knob is screwed on, no momentary slip of the friction parts has any effect. The writer has used this clutch on all sizes of high-speed lathes with gratifying results.

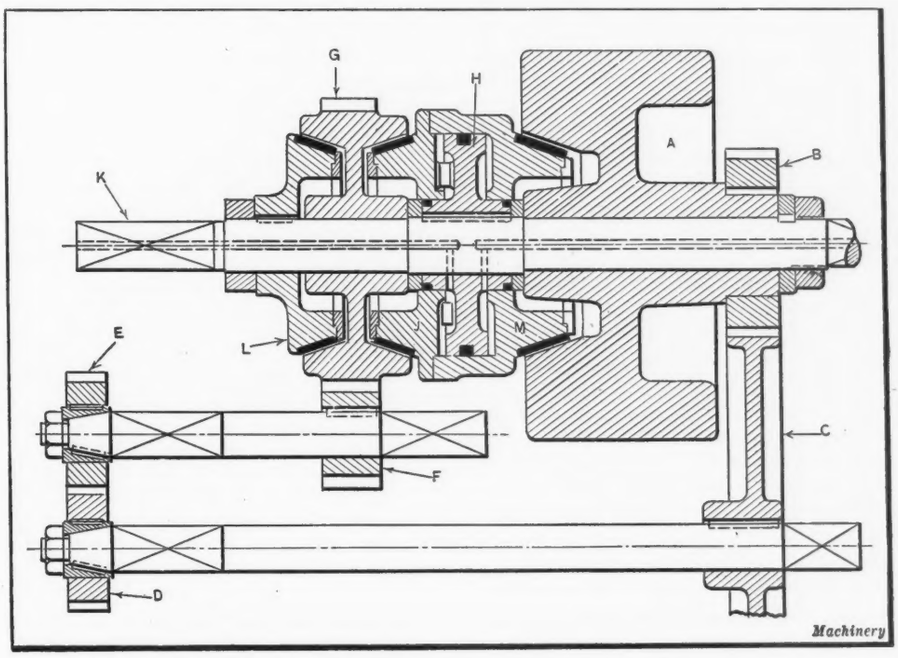


Fig. 5. Pneumatically Controlled Friction Clutches incorporated in a Planer Drive

Conical Clutch Applied to Planer Drive

An interesting application of conical clutches to an 8- by 8- by 20-foot planer built some years ago by William Sellers & Co., is illustrated in Fig. 5. The particularly interesting features of this application, are, first, the comparatively large amount of power transmitted by the clutch (50 horsepower); second, the application of the axial pressure pneumatically; and third, the use of a conical clutch for such strenuous duty as the repeated reversal of a heavy planer table.

Until the advent of the direct-coupled motor drive, the problem of driving heavy planers was a difficult one, as the belts on the ordinary shifting-belt drive were necessarily so heavy and wide that it was almost impossible to shift them sidewise quickly enough to meet the needs of the operation. As a consequence, all sorts of expedients were resorted to in attempting to overcome the difficulty, although very few friction clutches were tried, in spite of the fact that such an arrangement, if successful, possesses marked advantages for driving a planer table. For instance, the inertia of the reversing parts can be considerably reduced, and since it is these which absorb most of the power required at reversal, any reduction which can be made will not only lessen the power consumption, but tend toward quicker operation. Further, the engagement and disengagement of a friction clutch is ordinarily quicker than the shifting of belts, so that here, again, there are possibilities of faster operation by the use of clutches.

In the drive illustrated in Fig. 5, the clutches are used to drive shaft *K* from pulley *A*, which runs loosely on the shaft and constantly in one direction. On the hub of pulley *A* is a pinion *B* which drives gear *G* through reducing gears *C*, *D*, *E*, and *F*. Gear *G* is also mounted loosely on shaft *K*. It is evident that gear *G* runs in the opposite direction to pulley *A* and at a reduced speed, depending upon the ratio of the gears in the train. Pulley *A* is machined on one side to form the receiving half of a conical friction clutch, and gear *G* is machined similarly on both sides. The two conical elements *J* and *M* are bolted together and form an air-tight cylinder, free to move back and forth on disk *H*, which is keyed and pinned to shaft *K* and serves as a piston in the cylinder.

In order to make shaft *K* rotate with the friction clutch members, head *J* of the cylinder is provided with notches into which teeth on piston *H* project, thus forming a jaw clutch and permitting end movement, while at the same time compelling the parts to revolve together. When air is admitted through the center of shaft *K* to the space between the parts *H* and *M*, friction cone *M* is pressed against the pulley, causing the clutch to rotate with the pulley. This movement is transmitted through piston *H* by the clutch teeth, causing shaft *K* to turn in the same direction for effecting the return movement of the table. Admitting air through the opposite end of shaft *K* to produce the forward movement of the table, will cause clutch *J* to engage gear *G* and force it against the clutch *L* which is keyed to the shaft. The reduction gears *D* and *E* are mounted on split bushings which have conical holes that permit the gears to be changed quickly.

In the operation of this planer, table dogs actuate an air valve, admitting compressed air alternately into the opposite ends of the cylinder, and by regulating the amount of air admitted, the speed of the reverse can be closely controlled. The table can be brought to rest promptly and started up in the opposite direction without shock. There is no reversal of high-speed pulleys, and the flywheel action of parts whose motion is reversed is reduced to a minimum. Pulley *A* may be driven from a countershaft in the ordinary manner, or from a motor. The clutch surfaces are covered with leather to increase the frictional grip. The flywheel driving pulley is about 30 inches in diameter.

* * *

Practically all the documents of the Japanese Patent Office were destroyed in the recent earthquake. Temporary rules have been drawn up to cover the existing emergency. Manufacturers in the United States who have made patent application in Japan ought to communicate immediately with their resident patent representative in that country to ascertain that the requirements made necessary through the emergency rulings are being complied with.

Semi-automatic Lathe of Interesting Design

By CHAUNCEY C. WALKER

THERE are few branches of the metal-working industry that offer more opportunities for the development of special machines than the silverware business, because in this branch, with the exception of rolling, drawing, and stamping, there are few complete machine operations. The other processes involved, such as casting, cleaning, soldering, buffing, plating, and engraving are performed by hand. Even the ball-bearing tables on which the work is revolved in soldering are turned by the finger tips of the right hand while the flame is applied with the left hand. Tender fingers and an uneven surface speed are the results, and these could be avoided by simply substituting a friction drive, the speed of which could be controlled by the foot. Competition is severe in silverware manufacture, especially in the lower grades which must be produced in large quantities. This factor should make the field particularly attractive to the designer of special machines.

The turning on a machine of parts cast from black metal (94 per cent lead and 6 per cent antimony) and parts spun or drawn from white metal (Britannia) has been the subject of experiments by not a few concerns. But these have been unsuccessful largely because of the lack of a uniform feed and of a cutter that would leave a burnished finish with only a single cut. It is hardly probable that the proper form of cutter to use in this work would bear a near relation to any tool used in present practice. As finish and production, rather than accuracy, are the objectives, and the structural resistance of the metal to cutting is almost negligible, a certain amount of liberty may be taken in the design of tools for this work. The present article will describe a semi-automatic lathe and tools designed and built for turning these cast, spun, or drawn parts.

Construction of the Machine

The primary parts of the machine, as may be seen by referring to Fig. 2, are the bed, tailstock, and legs of a spinning lathe, with the addition of a special heavy headstock and a cam-controlled cross-slide or tool carriage. Power for the feed is taken from a countershaft by belt, and delivered to the five-step V-type cone pulley at the left-hand end of the machine. From the shaft of this cone pulley, power is transmitted, through worm-gearing, a cam, and a cam-lever, to shaft *A* at the rear of the machine; on shaft *A* is mounted the yoke-lever *B*, which, in turn, is connected to the cross-slide, and actuates this member transversely across the bed of the lathe.

The hand-lever on the front of the machine at the left of the cross-slide, when thrown to the left, engages the feed, to advance and return the cross-slide. This occurs during one revolution of the cam at the left-hand end of the bed. The feed is automatically disengaged at the end of the cycle by means of the stop cam-arm *C* and the stop-lever *D*, and at the same time the hand-lever is returned to its original position. The operator may stop and start the feed at any time with this hand-lever. The cycle of an operation ranges from ten to thirty seconds, depending on which vee of the cone pulley the driving belt engages, the cycle of each step varying 5 seconds from the adjacent ones.

The special headstock is of simple construction, and is provided with a taper front bearing for the spindle which runs in a draw-in ring-oiled bronze bearing. A combination radial and thrust ball bearing is supplied for the spindle at the left-hand end of the headstock. The tailstock illustrated is being replaced by a lever-operated one which will considerably reduce the floor-to-floor time.

Character of the Work

Before describing the more interesting points in the design of this special machine, it would be well to explain the character of the work handled. Several examples are illustrated diagrammatically in Fig. 1; those at *a*, *b*, *c*, *d*, *e* and *f* are black metal castings, and the remaining ones are spun or drawn Britannia metal of about No. 20 gage. On these parts the maximum and minimum diameters, respectively, are 4½ inches and ⅝ inch. From 0.004 to 0.007 inch of stock is removed from the castings, the exact amount depending on the desired accuracy, while from 0.0015 to 0.002 inch of stock is removed from spun or drawn work. A chuck of the required form is supplied for each piece of work, as shown at *E*, Fig. 2, and the work is pressed against

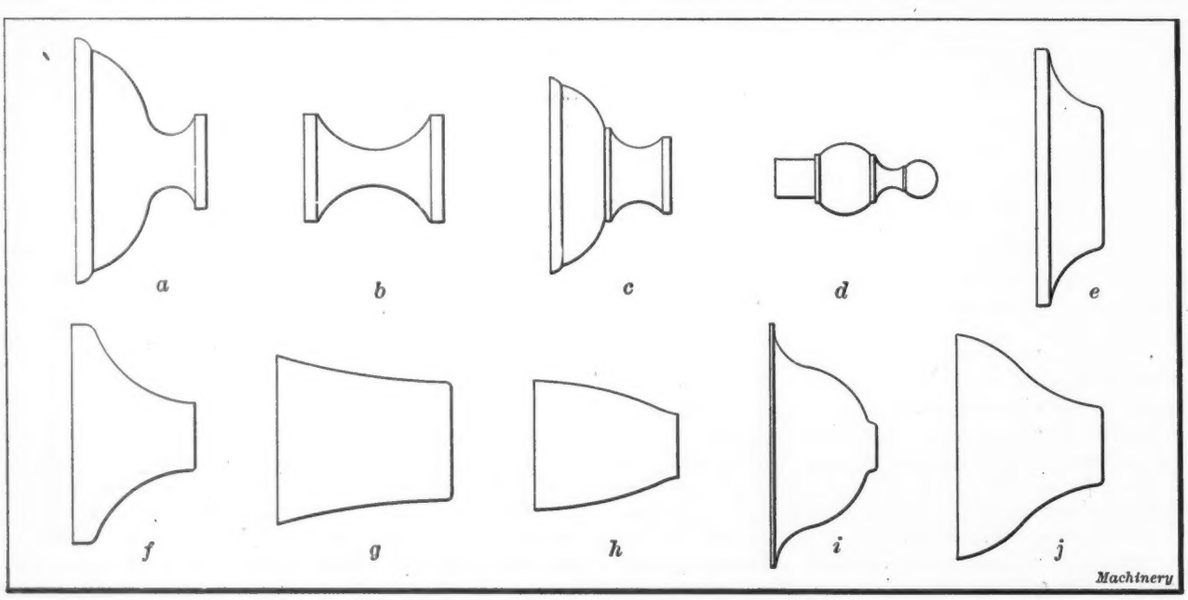


Fig. 1. Diagrammatic Outlines of Cast, Spun, and Drawn Parts which are turned on a Special Lathe before silver-plating

this chuck by means of the formed follower *F*, which is equipped with a ball thrust bearing. Proper seating of the work on the chuck is necessary to prevent chatter marks which should be caused only by the use of a dull cutter or by lack of proper adjustment in the operating parts of the machine.

By reason of the finish required, it is necessary that the cutter clear the work on the return stroke of the cross-slide and be thrown into the cutting position at the end of the stroke. As will be seen from Figs. 2 and 3, the cross-slide is constructed of two main parts *G* and *H*, the latter carrying the cutting tools. The lower part *G* is connected to the cross-slide yoke-lever *B*, and connection is also established between parts *G* and *H* by means of two eccentric shafts *I* and *J*. The lobes of both eccentric shafts bear in table *H*, and the ends of the shafts bear in the lower part *G*. The rear eccentric *J* is assembled with the lobe vertical and free to float, while the front eccentric *I* is assembled with the lobe horizontal and the movement controlled by dog *K*.

In Fig. 3, the cross-slide table *H* is shown raised, due to dog *K* having mounted the stationary cam *L*, and it is when the cross-slide is in this position that the cutting stroke takes place. At the end of this stroke the position of dog *K* is changed by the stationary cam *M*, so that the lobe of eccentric *I* is thrown downward, permitting the cross-slide to drop and clear the cutter from the work for the return stroke. The rear eccentric *J*,

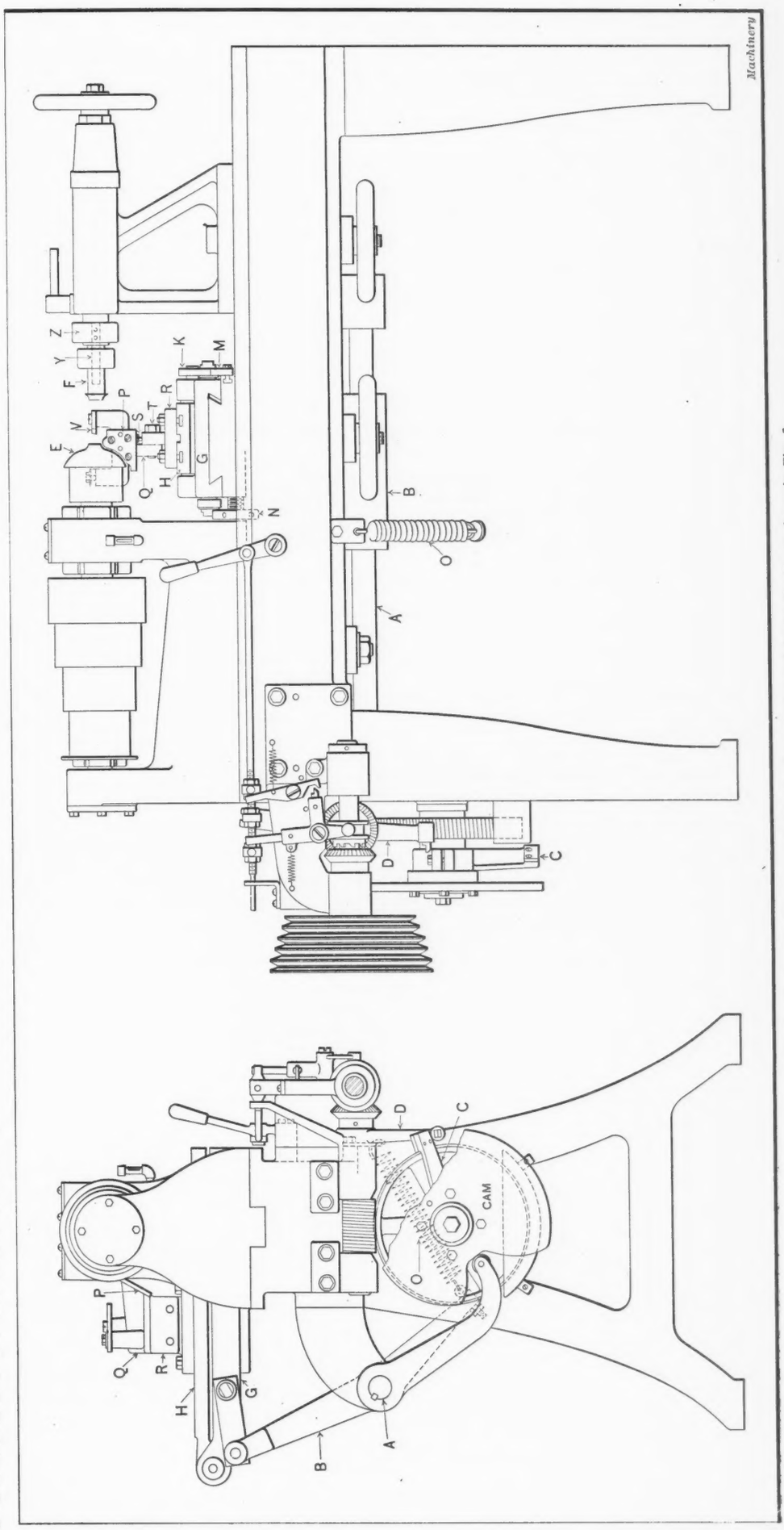


Fig. 2. Special Semi-automatic Lathe designed for form-turning and facing the Parts shown in Fig. 1

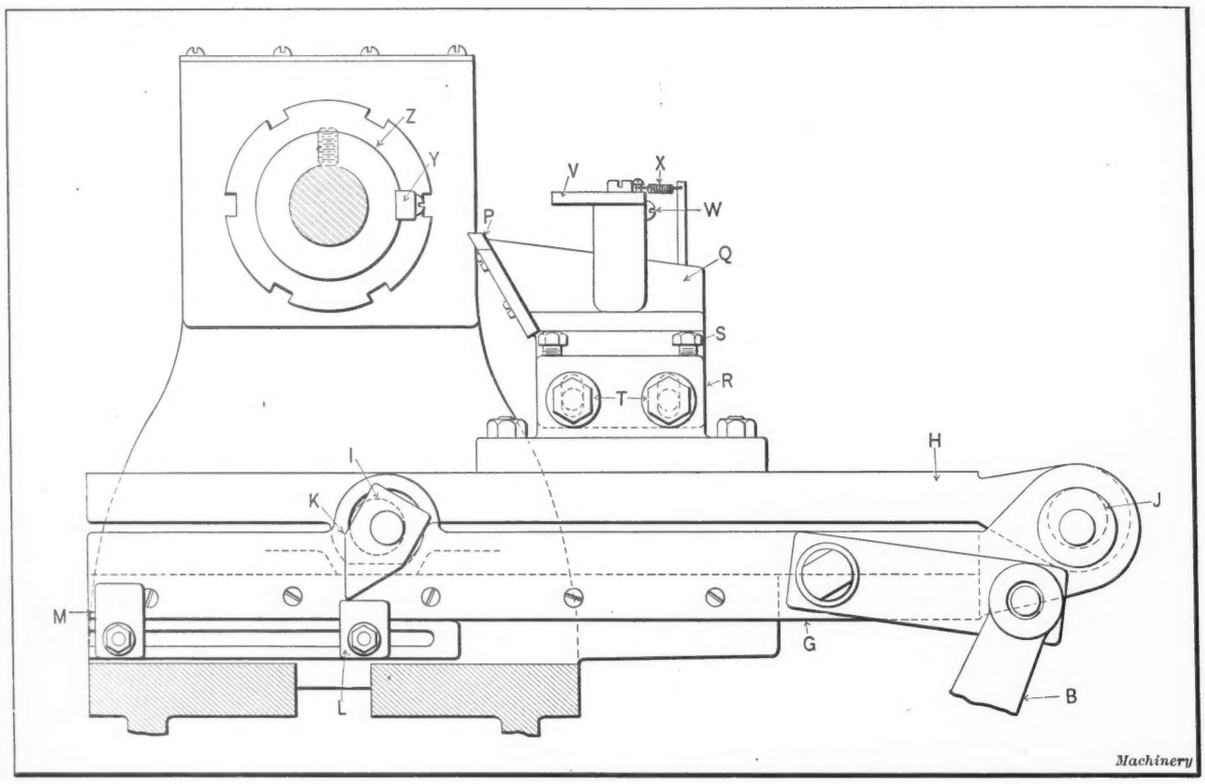


Fig. 3. Cross-slide of Semi-automatic Lathe illustrated in Fig. 2

which acts as the pivoting point for table *H*, absorbs the slight forward and backward movement of the table due to the vertical movement of eccentric *I*. A longitudinal adjustment of the cross-slide is available by means of a screw mounted in the headstock and attached to the base of the cross-slide, this screw being turned by means of collar *N*, Fig. 2.

The cross-slide is normally maintained in the rear position by means of the tension spring *O*, which is attached to the lower arm of the cross-slide yoke lever *B*. By this arrangement the slight play or backlash unavoidable with a positive cam is prevented from affecting the cross-slide movements.

Special Form Cutter Used

Two types of cutters have been found to give satisfactory results for this work; the one shown at *P* in Fig. 2 is used mostly for cast work, and has a back rake angle of about 30 degrees and a cutting clearance angle of about 3 degrees. Fig. 4 shows a cutter *P* used for finishing spun or drawn Britannia metal parts, such as shown at *g*, Fig. 1, the cutter being held in an upright position. The side rake of this cutter varies with the length of the work and with the cam throw, and the clearance angle is again about 3 degrees. The thickness of the cutter may vary from ⅛ to ⅜ inch, depending upon the quality of the steel used and the facilities for sharpening the cutter. The sharpening is best done on a light surface grinding machine equipped with a magnetic chuck, and finished with a medium fine stone.

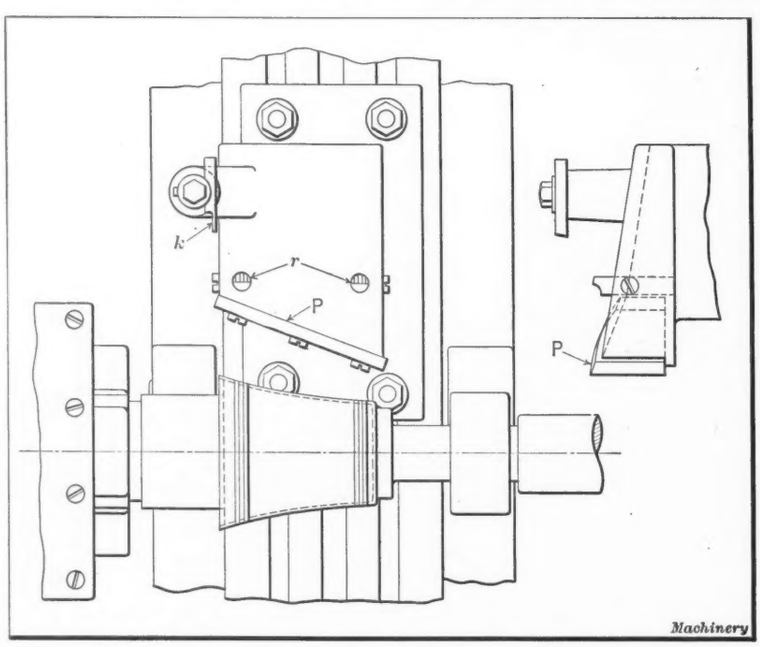


Fig. 4. Tooling Arrangement provided for finishing Part g, Fig. 1

At least two cutters should be kept in reserve, and they should have dowel holes drilled and reamed in them to a templet to suit the cutter-block, so that in replacing a cutter during a run of work, adjustment will be reduced to a minimum. A fairly high surface speed of the work and a proportionate cutter feed give the best results, but these demand the better class of high-speed steel in order to get the maximum endurance of the tool cutting edge. The slight percentage of silicon in the base metal of the work has an abrasive effect on the cutter. These cutting tools, together with facing tools, are carried on block *Q*, Fig. 3, which is bolted to base *R*. The latter is keyed to the cross-slide table *H*, and clamped to it by means of T-slot bolts. The complete tool set-up, with the chuck and cam, may be quickly removed to permit another tooling to be used, and may be replaced with little adjustment, the variation of the cutting tools in relation to the work being in a longitudinal direction only. Vertical adjustment of the cutter is obtainable by two cap-screws *S* and clamping screws *T*.

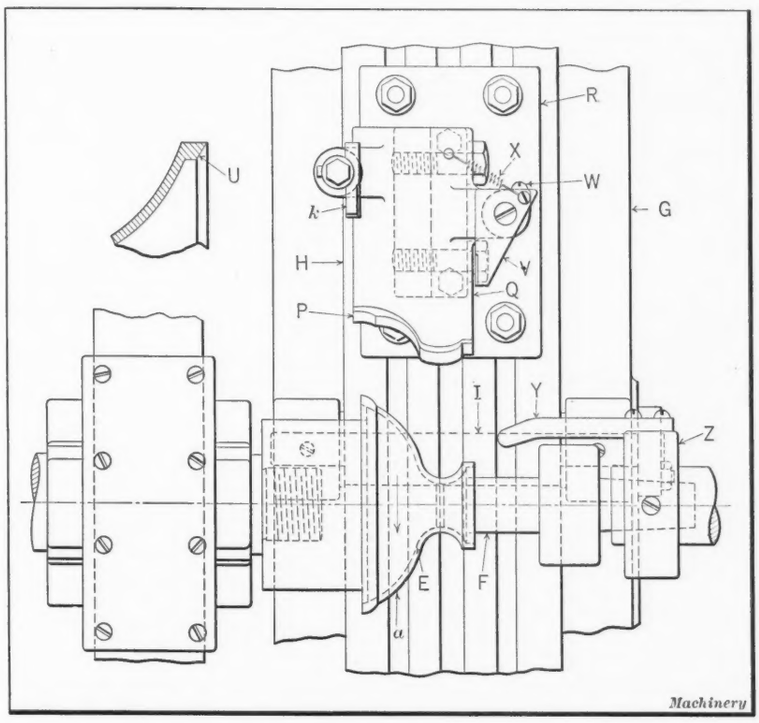


Fig. 5. Cast Part which is formed, faced at One End and under-cut at the Other End, as shown at U

The cast piece *a*, Fig. 5, in addition to being form-finished, must be faced at the top and bottom, the top or small-diameter end being under-cut, as shown at *U* in the detail view. This under-cut is accomplished by swinging, through the tension of spring *X*, the triangular cutter *V*, which is mounted on a cast upright of the cutter-block, with the heel of the cutter resting on the adjusting screw *W*. As the rear edge of cutter *P* completes the cut, the bevel side of cutter *V* comes into contact with the stationary arm *Y*, forcing the cutter against the work. Arm *Y* is attached to the adjustable collar *Z* on the tailstock spindle. Variation of the position of the tailstock spindle, in pressing follower *F* against the work, is hardly perceptible. The bottom or large-diameter end of the work is faced by the stationary tool *k*, which is clamped to another upright cast on the cutter-block, tools *V* and *k* operating at the same time.

In Fig. 6 is shown part *b*, Fig. 1, which requires an under-cut at both ends. These cuts are taken by two swinging cutters *l* and *m*, which are mounted in a manner similar to cutter *V*, Fig. 5. There are adjusting screws *n* between the pivoting points, and at the completion of the form cut taken by cutter *P* these screws come in contact with plate *o* and throw both cutters against the ends of the work. Arm *p* is placed high enough on the headstock to clear the highest point of the tools. Because of the short tool travel required for this piece, a two-lobe cam is used on the left-hand end of the machine and a two-stop cam-arm *C*, Fig. 2, is provided. With these alterations, a piece is completed at each one-half revolution of the cam.

Drawn or spun Britannia metal parts are chucked and held as shown in Fig. 4, in the same manner as cast parts. In this illustration, the side rake of the cutter is clearly shown. The single trimming tool *k* is held in the same way as that in Fig. 5. Back of the form cutter are two scoring tools *r* which pass under the work as they follow the cutter. Because only from 0.0015 to 0.002 inch of stock can be removed on this class of work, there must be an almost uniform relation between the cutter, work, and functioning elements of the machine. The design has been so arranged that all tools pass beneath the work after completing the cut.

* * *

LEAF SPRING DEFINITIONS

The following definitions have been proposed as standard for leaf springs, by a committee of the Society of Automotive Engineers. They are intended primarily to apply to the conventional semi-elliptical type of automotive spring.

Load—The number of pounds to be carried by the spring. The *Rated Load* is the number of pounds to be carried by the spring at a given spring height and includes the body, passengers, and normal pay-load for which the vehicle is designed.

Unsprung Weight—The total weight of all parts not supported on the springs, including springs, axles, wheels, rims, tires, etc.

Spring Height—The normal distance from a line through the centers of the spring eyes to the face of the spring seat at its center. The *Load Height* is measured with the spring under its rated load.

Clearance—The maximum distance the spring can deflect from a given position. The *Load Clearance* is measured from the rated load position of the spring.

Opening—The normal distance from a line through the centers of the spring eyes to the face of the main leaf in line with the center of the spring seat.

Length—The distance between the centers of the spring eyes. The *Load Length* is measured with the spring under the rated load.

Flexibility—The number of pounds required to deflect the spring 1 inch measured over the range of from 75 to 125 per cent of the rated load.

Deflection—The travel, in inches, of the spring under the application of a specified load in pounds.

In the opinion of the chairman of the committee, one of the most beneficial standards that the society could sponsor would be for the dimensions of leaf-spring stock, because of the unnecessary variety of stock sizes used at present.

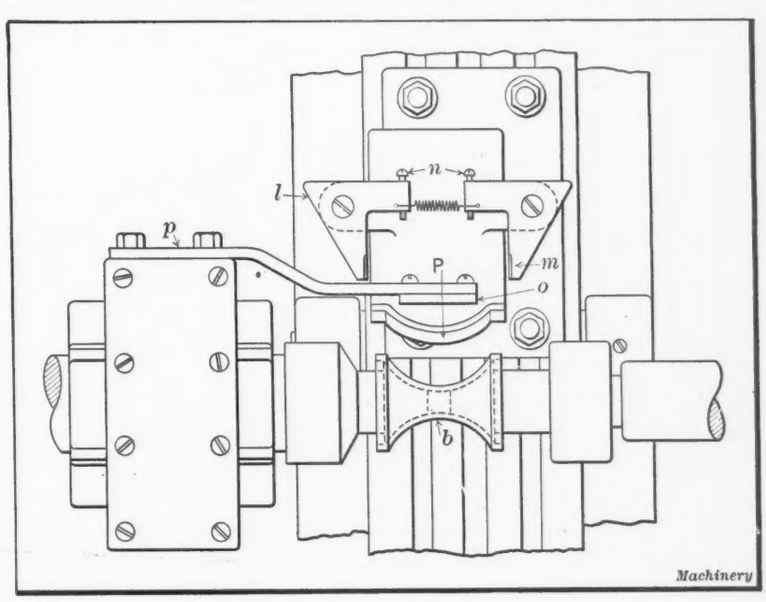


Fig. 6. Tooling for under-cutting Both Ends of Part b, in Addition to forming

Coil Spring Calculations

By JOHN W. ROCKEFELLER, Jr., Manager, Spring Division, John Chatillon & Sons, New York City

IN the design and manufacture of springs for measuring instruments and for valves used in internal combustion engines, the manufacturer frequently finds that, in spite of the many excellent articles that have been published on the subject, he is forced to fall back upon the most fundamental formulas for spring calculation, which are, in most cases, specialized types of the general formulas for the strength of materials.

This is due to the fact that in the majority of instances the various charts and tables that have been published as an aid to the designer leave either too much or too little to his selection and judgment. In most instances, the maker of the chart has selected an arbitrary figure for the maximum allowable fiber stress in the steel. Obviously, a spring operating the valve in an airplane engine will not function safely under a stress that might be satisfactory for a spring compressing not more than several times an hour, nor can a straight carbon steel spring be expected to operate safely under a stress that might be quite within the range of a special alloy steel spring.

Charts for Coil Spring Calculations

The accompanying charts (Figs. 1 and 3) have been used successfully in designing springs for extremely sensitive spring balances, as well as airplane and automobile engine springs for which maximum fiber stresses of a very low magnitude only were allowed. The charts are not proposed as a panacea for all coil spring ailments, nor is it claimed that their use will reduce calculations to an entirely mechanical process. On the other hand, they will indicate clearly excessive fiber stresses, and with their aid, the time required for ordinary spring calculations can be reduced at least 50 per cent. The charts are made for the calculation of steel springs only, and cannot be used for brass or phosphor-bronze springs.

Four factors are graphically represented in the charts, any two of which determine the remaining two:

1. The horizontal lines indicate the mean diameter of the coil, in inches.

2. The vertical lines show the deflection per solid inch of coil under a load of 100 pounds.

3. The light oblique lines represent the size of wire from which the spring is coiled. In Fig. 1 they correspond to Washburn & Moen gage sizes for circular-section wire, and in Fig. 3 they represent the width of square-section wire in fractions of an inch.

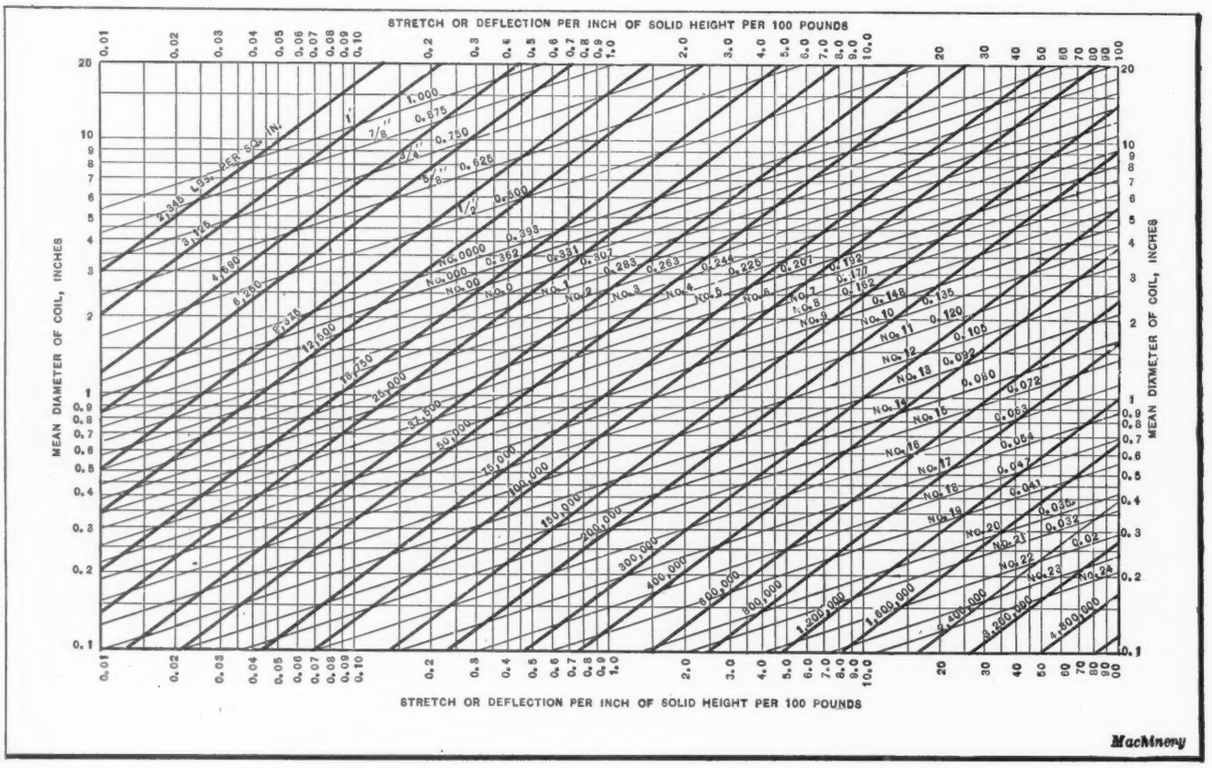

STRETCH OR DEFLECTION PER INCH OF SOLID HEIGHT PER 100 POUNDS
MEAN DIAMETER OF COIL, INCHES
STRETCH OR DEFLECTION PER INCH OF SOLID HEIGHT PER 100 POUNDS
MacMinery

Fig. 1. Chart used in designing Coil Springs to be made of Circular-section Wire

4. The heavy oblique lines show the fiber stress in the steel when a load of 100 pounds is imposed on the spring.

Use of the Charts

The use of the charts may be best illustrated by an example. Assume that it is required to find the stretch and fiber stress in an extension spring when a load of 20 pounds is imposed upon it, the solid length of the coil being 4 inches, the mean diameter, 0.75 inch, and the wire, No. 15 gage or 0.072 inch in diameter.

Fig. 2 shows how the values of this spring may be found in Fig. 1 after locating the point where the 0.072-inch wire line intersects the 0.75-inch mean diameter line. It will be seen that the stretch per inch of solid height C is 15 inches under a load of 100 pounds. Since the spring has a solid height of 4 inches and only 20 pounds is to be imposed upon

it, the deflection per inch of solid height will be as follows:

$$\frac{15 \times 20 \times 4}{100} = 12 \text{ inches}$$

Referring again to Fig. 1 and interpolating between the stresses of 400,000 and 600,000 pounds per square inch, it will be found that the stress S for the spring selected is 500,000 pounds per square inch under a load of 100 pounds. If only 20 pounds is imposed upon the spring, the fiber stress will be 1/5 × 500,000 or 100,000 pounds per square inch. It is apparent that for ordinary carbon steel such a fiber stress would be excessive.

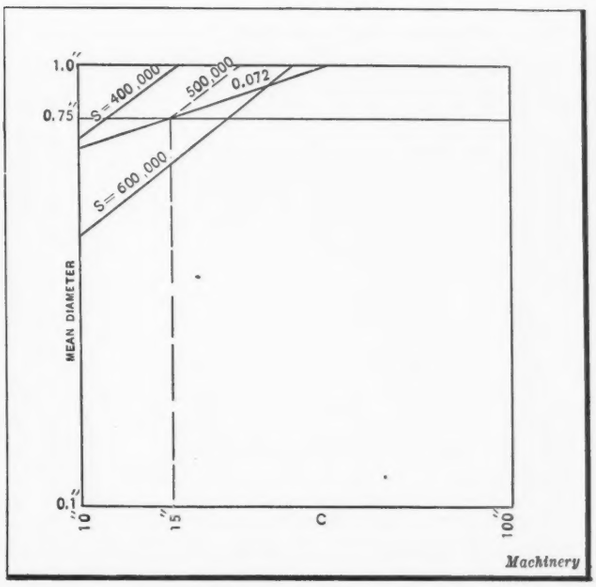


Fig. 2. Diagram illustrating the Method of using the Spring Charts

Let us redesign this spring to work at a stress within its elastic limit, without changing its length or deflection under a given load. It is obvious that the stretch per inch with a load of 100 pounds must remain the same, and for this reason the new spring must be represented by the same vertical line in Fig. 1 as the original spring. Assuming that the stress under a load of 20 pounds should not exceed 80,000 pounds per square inch, then S, for a load of 100 pounds, should not be greater than $\frac{80{,}000 \times 100}{20} = 400{,}000$ pounds.

In tracing up the vertical 15-inch line, the first wire-gage line encountered after the 400,000-pound stress line is passed, is the No. 13 (0.092 inch), and the corresponding mean diameter is about 1.1 inches. Then the dimensions of the new spring, designed to stretch the same distance as the original under the same load and to be the same length, are as follows: Mean diameter of coil, 1.1 inches; diameter of wire, 0.092 inch; and length of solid coil, 4 inches.

The fiber stress is seen to be 350,000 pounds per square inch with a load of 100 pounds or 70,000 pounds per square inch under the imposed load of 20 pounds. Thus, when the mean diameter of the coil may be increased, the redesigning of a spring to work at a proper fiber stress becomes a very simple matter.

The chart shown in Fig. 3 for square-section wire is used in exactly the same way as the chart in Fig. 1, and both charts can be used for compression as well as extension springs.

* * *

The cement industry has grown so rapidly and has achieved such great importance in the United States, and the use of cement in the construction of roads, bridges, and buildings has become so widespread that the intelligent and appropriate use of this material becomes a matter of great economic interest to the public. Research work is being carried on by the Bureau of Standards and by various public and private research laboratories and commercial and professional organizations relating to the properties, characteristics, proper use of cement, and improvement in methods, equipment and appliances. In order to co-relate the results of such scientific and technical activities, the Secretary of Commerce has appointed an advisory committee to make a comprehensive survey of the properties and uses of cement and concrete, under the general direction of the Department of Commerce. It is believed that such concentration of effort as the committee proposes to bring about will produce material results in the elimination of wasteful duplication of effort.

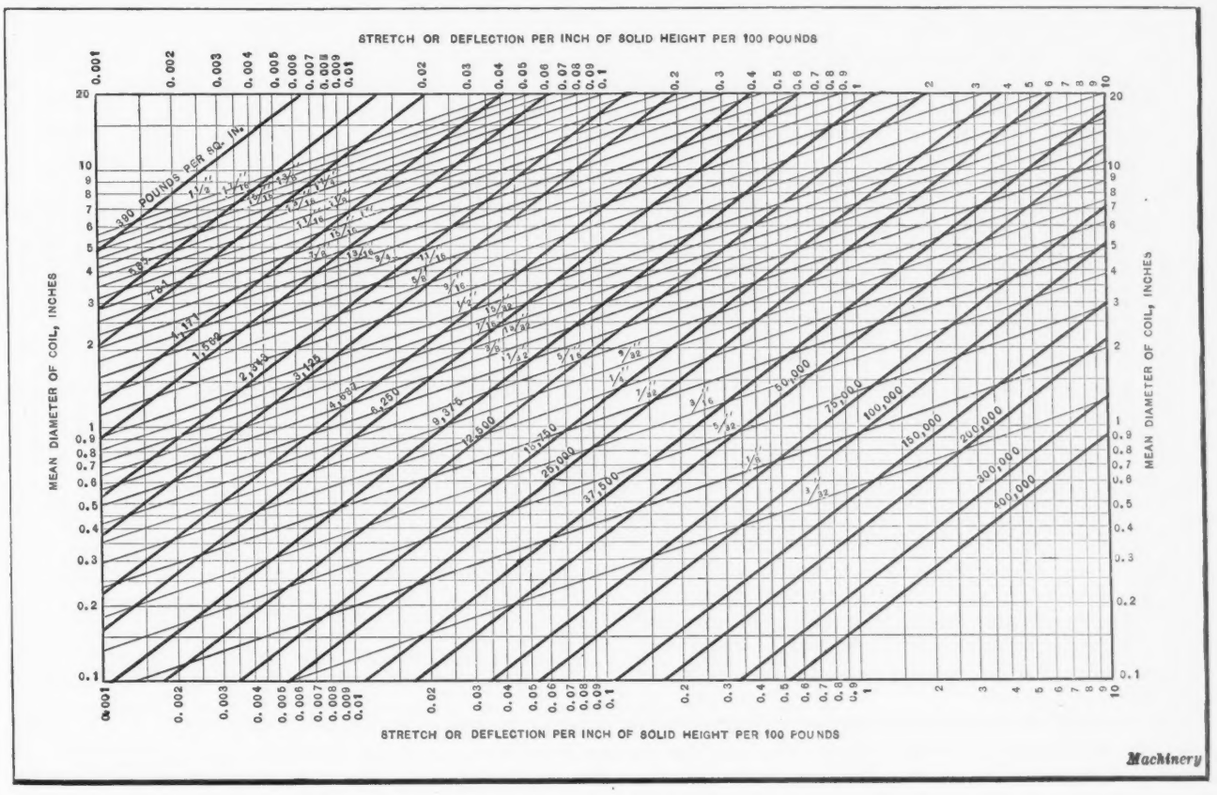
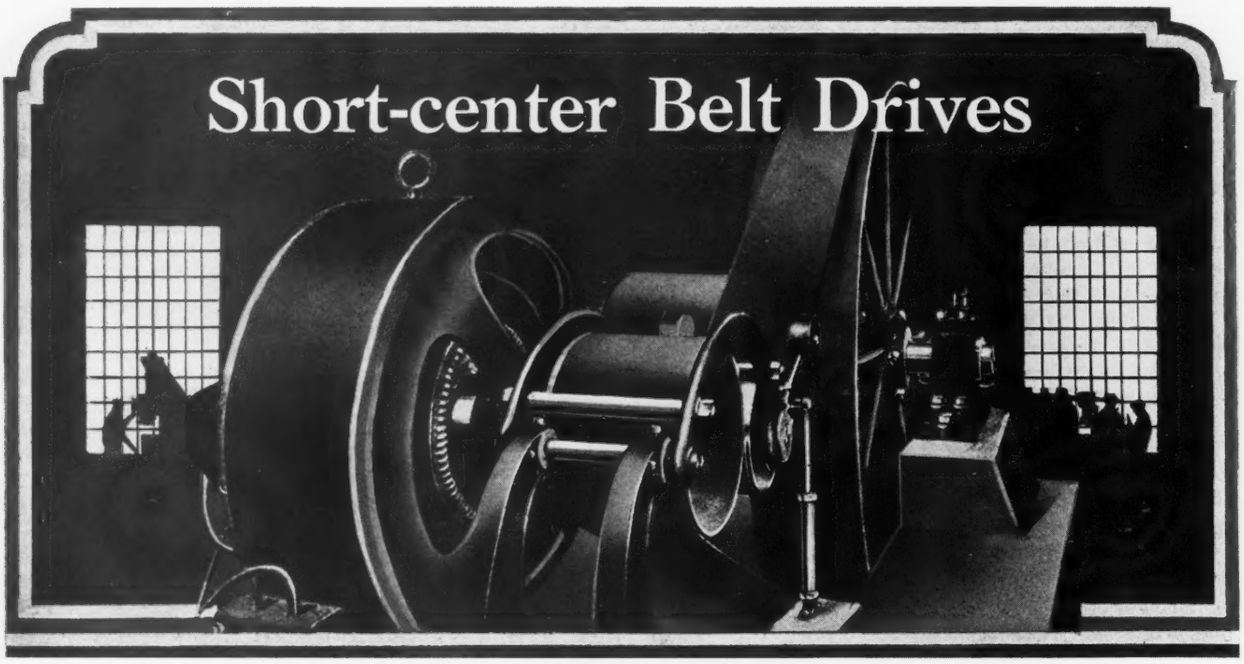


Fig. 3. Chart intended for Use in designing Square-section Wire Coil Springs

Short-center Belt Drives



Determining Coefficient of Friction and Procedure in Designing Drive for Transmitting a Given Amount of Power—Second of Three Articles

By GUSTAVE A. FRENKEL

The constructional features of modern short-center belt drives, as well as their advantages and general methods of arrangement for different operating conditions, were dealt with in June MACHINERY. In this article, the calculations for determining the power-transmitting capacity of a short-center belt drive will be explained, in conjunction with a specific example illustrating the application of the formulas to a typical belt-transmission problem.

Recent researches and tests made with numerous belt drives of all kinds have proved that certain theories about belting which have been adhered to are not reliable, and in this article facts will be presented which are of considerable importance to all requiring accurate information on belt transmissions. One important factor entering into the design of belt drives which should be considered is the pulley diameter, as this influences the coefficient of friction, resulting in a far higher effective pull for larger pulleys than for small ones at the same velocity. Another point is that the creep of the belt, caused by the ratio of stresses, does not occur in the sense generally believed, because the change in stretch in the belt apparently cannot follow the quick change in tension at higher velocities; consequently a much higher value for the working tension of the belt can be used for the higher velocities than the lower, without fear of excessive and injurious stretch. (This explains the dropping off of the curve in the chart Fig. 3, in the June installment.)

The efficiency of a belt drive increases with increasing effective pull, remains almost constant when the effective pull reaches a certain value, and decreases with further increase in effective pull. The highest efficiency of a belt drive (0.94 to 0.98 per cent) is obtained within an effective-pull range of from 60 to 180 pounds per square inch of belt for light belts, and from 100 to 300 pounds per square inch for heavy belts. These efficiency values are based upon losses due to creep, stiffness, and air resistance of the belt, but losses due to bearing friction and air resistance of the pulleys are not included.

In the formulas to be given for calculating short-center belt drives, the following notation will be used:

S_n = total tension in running belt on tight side, in pounds;
S_o = total tension in running belt on slack side, in pounds;
S_r = total tension in belt when at rest, in pounds;
s_r = belt tension, in pounds per square inch, when at rest;
θ = arc of contact of belt on pulley, in radians = $(\pi \div 180) \times$ arc, in degrees;
α = arc of contact of belt on pulley, in degrees;
μ = coefficient of friction between belt and pulley;
c = centrifugal force for one cubic inch of belt, in pounds;
P = total turning or tangential force exerted by entire width of belt = $S_n - S_o$, in pounds;
p = turning force transmitted by a belt having a cross-sectional area of one square inch, in pounds;
f = cross-sectional area of belt, in square inches;
v = velocity of belt, in feet per second;
V = velocity of belt, in feet per minute;
q = weight of belt per cubic inch, in pounds;
q_1 = weight of belt per foot, of length, in pounds;
$q_2 = q_1 \div f$ = weight of belt 1 inch square and 12 inches long, in pounds;
$S = S_n \div f$ = working tension of belt on tight side, in pounds per square inch;
s = tension per square inch on slack side of belt, in pounds;
e = basis of natural system of logarithms = 2.71828;
g = acceleration due to gravity = 32.2;
W = width of belt, in inches;
d = thickness of belt, in inches;
D = diameter of pulley, in inches; and
H = horsepower.

Working Stresses for Maximum Efficiency

The creep of a belt at lower velocities increases in proportion to the effective pull, and actual slip occurs when the ratio of tensions, which is equivalent to $\left(\frac{S_r + 0.5P}{S_r - 0.5P} = e^{\mu\theta}\right)$ has become so great that μ reaches a value of 0.6 to 0.8. Measurements of slip at various speeds have proved that the

diameter $D + d$ is the dimension to use for speed calculations.

Taking as a basis the working stresses which, by thorough tests, have been found to give a belt drive the highest efficiency, we are enabled to determine the correct coefficient of friction for any velocity and any pulley diameter since the frictional resistance has been found to be dependent on the diameters of the pulleys. The chart Fig. 14 gives these working stresses, in pounds per square inch, for various pulley diameters at various speeds. It may be stated that the tests for establishing these stresses extended over a period of several years and are reliable, as they were made with the greatest caution and thoroughness. Any drive, calculated in accordance with these stresses, will operate with as high an efficiency as can be obtained with a belt drive.

From a practical point of view it would be wearisome to consider the various stresses for every diameter of pulley. For the sake of simplicity they may be classed as "small pulleys," or those under 14 inches in diameter; "medium pulleys," varying from 14 to 36 inches in diameter; and "large pulleys," or those over 36 inches in diameter. An example illustrating the method of determining the coefficient of friction will be given, and anyone interested in this work may apply the same method to any diameter of pulley, with the aid of the stress chart. The exact value for a given diameter should be determined whenever an important drive of considerable magnitude is involved.

Determining Coefficient of Friction

To make it easier for the reader to understand, the graphic method has been chosen for the determination of the coefficient of friction. It has been explained that the highest efficiency of a belt drive is obtained with a certain stress, varying with the diameter of the pulley and the velocity of the belt. These effective stresses, established by tests, are represented by the corresponding working stresses of the belt, as shown by the chart, Fig. 14. As an example, a 24-inch diameter pulley will be taken. The corresponding working stresses for this diameter (see chart Fig. 14) are indicated by the line AB (Fig. 15). As these stresses are of theoretical value only, this line will be called the "theoretical stress line." The ordinates of this line represent the theoretical belt stress $S = s_r + 0.5p$ per square inch at any velocity. From this stress line AB we deduct the centrifugal force, according to the formula:

$$c = 12 \times \frac{q \times v^2}{g} \qquad (5)$$

The ordinates of the new line thus found correspond to the tension $s_r + 0.5p - c$. This is the tension per square inch in the tight strand of the belt. The inclined shaded part (Fig. 15) indicates the loss through centrifugal force.

As the coefficients of friction during tests were repeatedly as high as 0.6 and 0.8 before actual slip of the belt occurred, the value 0.5 can be used as a basis for further developments. If the arc of contact is assumed to be 225 degrees, then the equivalent in radians is 3.926. Inserting these values in the formula $\frac{e^{\mu\theta} - 1}{e^{\mu\theta}}$ we have

$$\frac{2.71828^{0.5 \times 3.926} - 1}{2.71828^{0.5 \times 3.926}} = 0.86$$

Dividing the ordinates of the line for the tension $s_r + 0.5p - c$ in the proportion 0.86 to 1, a curve is obtained, having ordinates representing the effective pull or turning force $p = (s_r + 0.5p - c)\frac{e^{\mu\theta} - 1}{e^{\mu\theta}}$ for any velocity of the belt. The horizontally shaded part represents the value $\frac{e^{\mu\theta} - 1}{e^{\mu\theta}}$. The area in the diagram indicating the effective pull p has been shaded vertically. It will be seen that the effective pull increases gradually with increasing speed up to a certain velocity. When the speed is increased beyond this point, the effective pull diminishes rapidly until, finally, the centrifugal force equals the working stress; then the effective pull or turning force and the power transmitted become zero. The highest effective pull p in this example, is attained at a velocity of 2950 feet per minute, and the zero point is reached at a speed of 8600 feet per minute.

Before we can proceed with the derivation of the coefficient of friction, the correct constant working stress of the belt must be established. This is accomplished by extending the ordinate representing the highest effective pull p, beyond the point a to its intersection with the theoretical stress line AB. Through this point of intersection a line

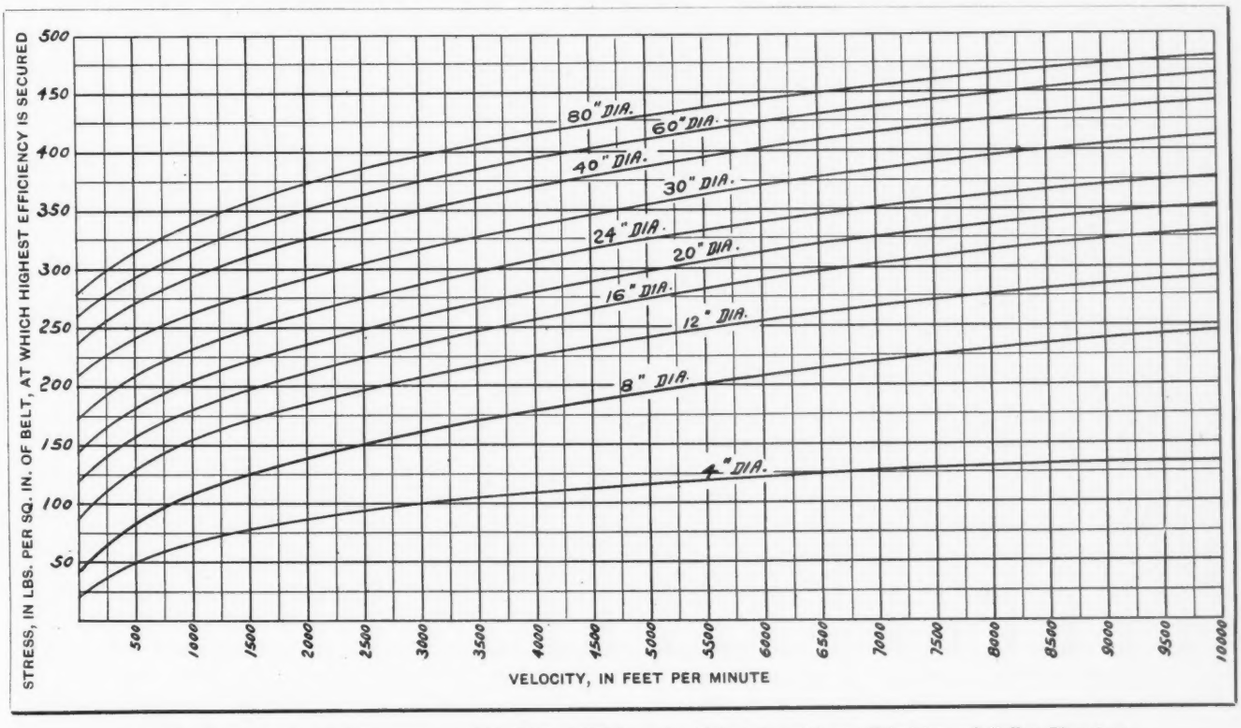


Fig. 14. Chart showing Belt Stresses at which Highest Efficiency is obtained for Different Velocities and Pulley Diameters

XY is drawn parallel to CD, whose ordinates represent the working stress. This ordinate, according to the scale of the diagram Fig. 15, is 290 pounds, which is the correct working stress per square inch of a belt for use on medium pulleys varying from 14 to 36 inches in diameter.

From the horizontal stress line XY the centrifugal force is deducted as was done with the theoretical stress line, and we find that the curve thus established intersects the effective stress curve at point b. This point indicates the maximum belt velocity, which cannot be exceeded without seriously affecting the transmitting power of the belt. The proper belt speed for medium pulleys is found to be at point a, in line with the highest effective pull and also in line with the greatest ratio of tensions.

We can now proceed with the derivation of the coefficient of friction by the aid of the diagram Fig. 15. As a basis we use the following equation:

$$p = (S - c)\frac{e^{\mu\theta} - 1}{e^{\mu\theta}} \qquad (6)$$

Hence,

$$\frac{p}{S - c} = \frac{e^{\mu\theta} - 1}{e^{\mu\theta}}$$

The letter A will be used temporarily as a substitute for the quotient $\frac{p}{S - c}$; the equation thus becomes:

$$A = \frac{e^{\mu\theta} - 1}{e^{\mu\theta}}$$

and by further solution:

$$Ae^{\mu\theta} = e^{\mu\theta} - 1$$

$$Ae^{\mu\theta} - e^{\mu\theta} = -1$$

$$e^{\mu\theta}(A - 1) = -1$$

$$e^{\mu\theta} = \frac{-1}{A - 1}$$

Substituting for A its original value $\frac{p}{S - c}$ the equation becomes:

$$e^{\mu\theta} = \frac{-1}{\frac{p}{S - c} - 1} = \frac{S - c}{S - p - c}$$

$S - p$ is equal to the tension s on the slack side of the belt. Substituting s, the equation can now be written:

$$e^{\mu\theta} = \frac{S - c}{s - c} \qquad (7)$$

which is the correct formula for the ratio of tensions in the belt.

Solving Formula (7) for μ we find:

$$\mu = \frac{\log \frac{S - c}{s - c}}{\log e^{\theta}} \qquad (8)$$

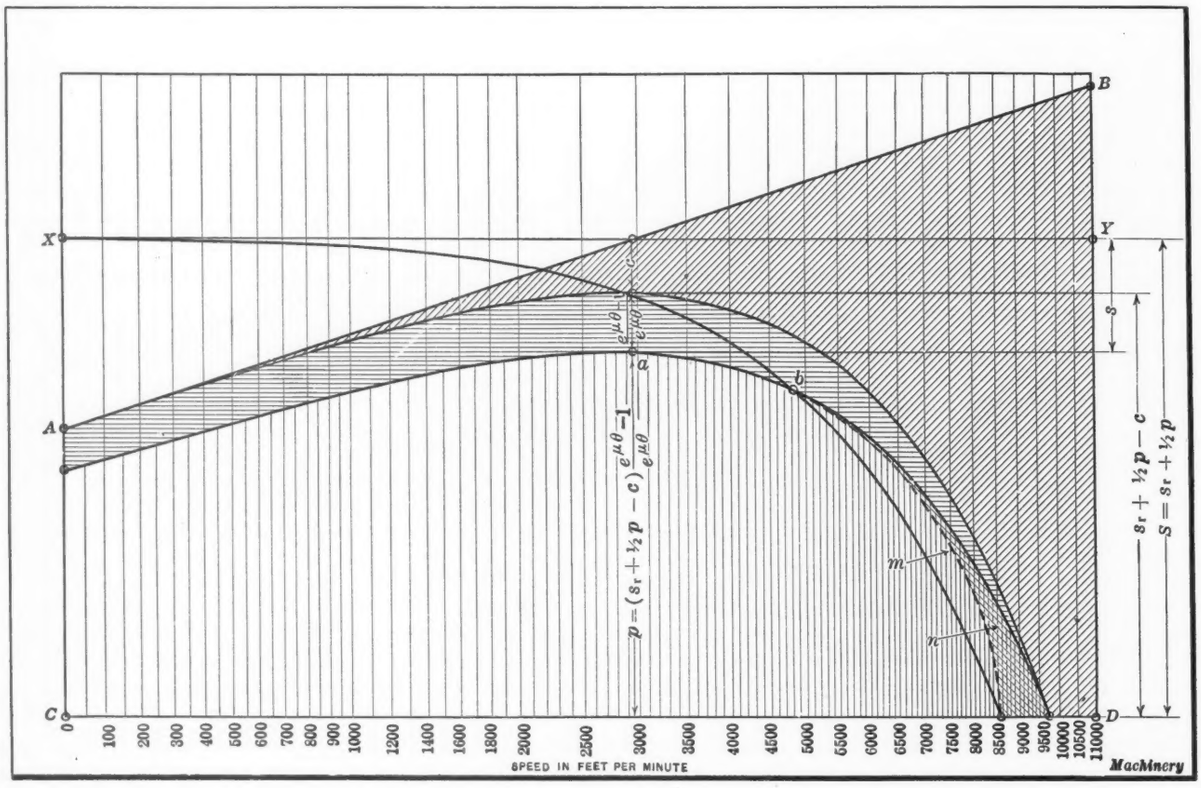


Fig. 15. Graphic Method of illustrating Procedure in determining Coefficient of Friction, Effect of Centrifugal Force, and Maximum Belt Velocity for Efficient Transmission

In the example, S has been found to be 290 pounds per square inch for pulleys of medium size; s and c can be found on the diagram Fig. 15, or by scaling the value of p on the diagram, s may be calculated by using the formula:

$$s = S - p$$

By using Equation (5), the value of c may be determined. Thus the coefficient of friction may be found for any velocity. The example has been solved for medium pulleys only, but the same procedure may be followed for small and large pulleys. Table 1 gives the coefficients of friction for all three classes of pulleys.

The correct working stresses have been found to be: 160 pounds per square inch for small pulleys; 290 pounds per square inch for medium pulleys, and 395 pounds per square inch for large pulleys. The maximum effective pull is maintained at a velocity of 2950 feet per minute for small pulleys, as well as for medium and large pulleys. The table giving the coefficients of friction for leather belts shows that the coefficient of friction is the same at this velocity of 2950 feet per minute, for any diameter of pulley. It further shows that there is a considerable decrease in the coefficient of friction in connection with small pulleys when the speed is decreased. This reduction becomes proportionately less

as the pulley diameter increases. If there were a possibility of increasing the pulley diameter to infinity, a condition would be reached where the coefficient of friction would be constant at any velocity.

It will be recalled that the curve representing the centrifugal force on diagram Fig. 15 intersects the effective stress curve at the point *b*. This point indicates the maximum belt velocity which should not be exceeded. The coefficient of friction reaches here its highest value and decreases again with further increase in speed. At higher belt velocities, where the effect of centrifugal force becomes serious, the effective stress line has to be modified, as indicated by the dotted part *m* of the curve. This is due to the fact that the horizontal stress line, from its point of intersection, is below the theoretical stress line *AB*. The shaded part *n* shows the loss in effective pull beyond the point *b*. This correction is immaterial, inasmuch as it occurs beyond the limit of belt velocity.

from Table 1. *S* equals 160 pounds per square inch for small pulleys under 14 inches in diameter; 290 pounds per square inch for medium pulleys from 14 to 36 inches in diameter; and 395 pounds per square inch for large pulleys over 36 inches in diameter.

The cross-sectional area of the belt is:

$$f = \frac{P}{p} \qquad (10)$$

From Equation (2) in the first installment of this article, the proper thickness of the belt is found to be:

$$d = \frac{D \times 0.15}{\sqrt[3]{S}}$$

and the belt width:

$$W = \frac{f}{d} \qquad (11)$$

TABLE 1. COEFFICIENTS OF FRICTION OF LEATHER BELTS ON IRON PULLEYS

Belt Speed, Feet per Minute	Pulley Size*			Belt Speed, Feet per Minute	Pulley Size*			Belt Speed, Feet per Minute	Pulley Size*		
	Small	Medium	Large		Small	Medium	Large		Small	Medium	Large
0	0.071	0.184	0.238	2700	0.456	0.470	0.475	5200	0.343	0.944	0.882
100	0.084	0.198	0.251	2800	0.472	0.479	0.483	5300	0.316	0.865	0.941
200	0.098	0.210	0.262	2900	0.495	0.490	0.489	5400	0.302	0.815	1.018
300	0.112	0.221	0.271	2950	0.500	0.500	0.500	5500	0.246	0.739	1.165
400	0.126	0.234	0.282	3000	0.536	0.507	0.505	5600	0.242	0.730	1.250
500	0.139	0.243	0.292	3100	0.552	0.518	0.508	5650	0.238	0.720	1.352
600	0.151	0.256	0.302	3200	0.585	0.539	0.519	5700	0.234	0.710	1.321
700	0.164	0.267	0.313	3300	0.627	0.545	0.528	5800	0.225	0.650	1.315
800	0.177	0.278	0.321	3400	0.678	0.561	0.536	5900	0.208	0.642	1.235
900	0.191	0.281	0.328	3500	0.794	0.586	0.553	6000	0.131	0.589	0.991
1000	0.204	0.297	0.339	3600	0.842	0.595	0.559	6100	0.106	0.578	0.974
1100	0.217	0.307	0.346	3700	0.975	0.612	0.567	6200	0.082	0.572	0.942
1200	0.227	0.318	0.353	3800	1.352	0.638	0.586	6300	0.025	0.560	0.900
1300	0.242	0.327	0.362	3900	1.160	0.656	0.590	6400	0	0.550	0.895
1400	0.253	0.336	0.371	4000	0.830	0.680	0.600	6500	.....	0.514	0.792
1500	0.266	0.346	0.380	4100	0.744	0.715	0.617	6600	.....	0.492	0.780
1600	0.280	0.357	0.389	4200	0.685	0.740	0.628	6700	.....	0.488	0.763
1700	0.295	0.368	0.396	4300	0.642	0.783	0.645	6800	.....	0.461	0.729
1800	0.307	0.375	0.405	4400	0.584	0.815	0.664	6900	.....	0.432	0.712
1900	0.317	0.386	0.413	4500	0.517	0.904	0.685	7000	.....	0.384	0.625
2000	0.331	0.398	0.420	4600	0.510	0.946	0.700	7500	.....	0.315	0.526
2100	0.345	0.408	0.427	4700	0.482	1.029	0.716	8000	.....	0.239	0.443
2200	0.362	0.417	0.435	4800	0.448	1.345	0.741	8500	.....	0.057	0.367
2300	0.376	0.426	0.442	4820	0.440	1.352	0.750	9000	.....	0	0.276
2400	0.392	0.437	0.451	4900	0.413	1.330	0.780	9500	.....	.....	0.226
2500	0.411	0.449	0.460	5000	0.378	1.102	0.816	10000	.....	.....	0.157
2600	0.425	0.455	0.466	5100	0.362	1.050	0.857	10500	.....	.....	0

Machinery

*According to the classification in this table, small pulleys are under 14 inches in diameter; medium sizes, from 14 to 36 inches in diameter; and large sizes, over 36 inches in diameter.

Summing up the foregoing, the following theorem has been proved:

The coefficient of friction between belt and pulley is constant for any diameter of pulley at a velocity where the highest effective pull is exerted; it decreases with decreasing speed and increases with increasing speed, reaching its highest value at a velocity where the effective pull equals working stress minus centrifugal force, and decreases with further increase in velocity, becoming zero at a point where the centrifugal force equals the working stress of the belt.

General Formulas for Belt Calculations

To find the belt stresses for a proposed short-center belt drive, the total turning force or tangential force has first to be calculated according to the formula:

$$P = \frac{H \times 33{,}000}{V} \qquad (9)$$

The arcs of contact having been established, we find the corresponding turning force (p) per square inch of belt from Tables 2, 3, and 4, which have been compiled for small, medium, and large pulleys. This value may also be determined from Formula (6). The value for μ may be taken

The total tensions in the tight and slack sides, respectively, are determined by the following equations:

$$S_n = fS = \frac{P}{p} \times S \qquad (12)$$

$$S_o = S_n - P \qquad (13)$$

Effective Weight on Slack Side of Belt

The determination of the effective weight K which has to be placed on the slack strand of the belt in order to produce the necessary tension, is beset with difficulties, owing to the fact that the angles α and β (Fig. 16) are subject to slight changes while the belt drive is in operation. These changes are caused by the elongation of the belt when a heavier load is applied and by its subsequent contraction when the load is reduced. Inasmuch as the tension roller under normal conditions will maintain its relative position, the effective weight K can be figured with sufficient accuracy for this condition. Any variation caused by differences in the angles α and β may be adjusted by shifting the equalizing weights on their levers.

To find the effective weight K, first establish the two angles α and β, by means of the resultant of the stresses S_o,

TABLE 2. TURNING FORCE (p), IN POUNDS, TRANSMITTED BY A LEATHER BELT HAVING A CROSS-SECTIONAL AREA OF ONE SQUARE INCH

Values for Small Pulleys Less Than 14 Inches in Diameter*

Arc of Contact, Degrees	Velocity of Belt, in Feet per Minute															
	100	200	300	400	700	1000	1300	1600	1900	2200	2500	2800	3100	3400	3700	4000
180	37.5	42.5	47.5	52.2	64.0	74.5	82.2	88.1	92.2	96.1	98.9	101.0	101.4	100.20	97.50	90.20
184	38.1	43.2	48.3	53.1	65.1	75.6	83.4	89.3	93.5	97.2	99.8	102.0	102.3	100.90	98.00	90.64
188	38.6	43.9	49.0	54.0	66.2	76.7	84.5	90.7	94.7	98.3	100.7	103.0	103.1	101.60	98.50	91.08
192	39.3	44.7	49.9	54.9	67.2	77.8	85.7	91.8	95.9	99.4	101.7	103.9	103.9	102.30	99.10	91.46
196	40.0	45.5	50.9	55.7	68.1	78.9	86.9	93.0	97.0	100.3	102.6	104.7	104.6	102.90	99.70	91.78
200	40.6	46.2	51.8	56.5	69.0	80.0	88.0	94.1	98.0	101.1	103.5	105.5	105.2	103.50	100.30	92.10
204	41.3	47.1	52.8	57.5	70.1	81.1	89.1	95.2	99.0	102.1	104.4	106.3	105.9	104.10	100.70	92.46
208	42.0	48.0	53.6	58.5	71.2	82.2	90.2	96.2	100.0	103.1	105.3	107.1	106.5	104.70	101.00	92.82
212	42.8	48.9	54.4	59.5	72.3	83.2	91.2	97.2	101.0	104.1	106.1	107.8	107.1	105.30	101.40	93.10
216	43.6	49.6	55.2	60.4	73.3	84.2	92.3	98.1	102.0	105.0	106.9	108.4	107.7	105.80	101.90	93.30
220	44.3	50.2	56.0	61.3	74.3	85.2	93.4	99.0	103.0	105.9	107.8	109.1	108.3	106.20	102.30	93.50
224	44.9	50.9	56.8	62.0	75.2	86.2	94.3	99.9	103.9	106.7	108.5	109.7	108.8	106.60	102.60	93.70
228	45.4	51.7	57.6	62.7	76.1	87.1	95.2	100.8	104.8	107.5	109.2	110.2	109.2	107.00	103.00	93.90
232	46.1	52.4	58.4	63.5	77.0	88.1	96.1	101.7	105.7	108.4	109.9	110.8	109.8	107.40	103.40	94.10
236	46.8	53.2	59.2	64.4	78.0	88.9	97.1	102.7	106.5	109.2	110.6	111.4	110.3	107.80	103.80	94.30
240	47.4	54.0	60.0	65.2	78.9	89.8	98.1	103.7	107.5	109.9	111.3	112.0	110.8	108.20	104.10	94.50
244	48.1	54.6	60.8	66.1	79.8	90.7	98.9	104.5	108.3	110.6	111.9	112.5	111.2	108.60	104.34	94.70
248	48.8	55.2	61.5	67.0	80.6	91.7	99.8	105.4	109.1	111.3	112.5	113.0	111.5	108.90	104.58	94.90
252	49.4	55.8	62.3	67.9	81.5	92.5	100.6	106.2	109.9	112.0	113.1	113.5	112.0	109.30	104.80	95.04
256	50.0	56.4	63.1	68.7	82.3	93.4	101.4	107.0	110.7	112.6	113.7	114.1	112.5	109.60	105.00	95.12
260	50.7	57.1	63.8	69.5	83.1	94.3	102.2	107.7	111.4	113.3	114.3	114.6	113.0	109.80	105.20	95.20
264	51.3	57.9	64.5	70.2	84.0	95.1	103.2	108.5	112.1	113.9	114.9	115.1	113.3	110.12	105.52	95.32
268	52.0	58.6	65.2	70.8	84.8	95.9	104.1	109.2	112.8	114.6	115.4	115.6	113.6	110.44	105.84	95.44
272	52.6	59.4	65.9	71.5	85.7	96.8	105.0	110.0	113.6	115.3	116.1	116.1	114.0	110.74	106.10	95.56
276	53.2	60.1	66.6	72.4	86.5	97.6	105.8	110.8	114.4	116.1	116.8	116.7	114.3	111.02	106.30	95.68
280	53.8	60.7	67.3	73.2	87.3	98.5	106.5	111.5	115.1	116.8	117.5	117.2	114.6	111.30	106.50	95.80

Machinery

*This table is based upon a belt stress of 160 pounds per square inch of cross-sectional belt area.

and S_{o2}, in the short and long sections, respectively, of the slack side (see diagram Fig. 16). Then draw a line perpendicular to the line MF and intersecting point O. Now draw the two components OB and OC of the resultant OA; OB represents the effective weight K which has to be applied to the slack strand of the belt. The force OC is taken up by the arm, and manifests itself as a tensile stress which the arm has to withstand.

Instead of employing the graphic method for finding the effective weight K, the following formulas may be used:

$$K = S_{o1} \frac{\sin(a+\beta)}{\sin\beta} \cos\gamma \qquad (14)$$

$$K = S_{o2} \frac{\sin(a+\beta)}{\sin a} \cos\gamma \qquad (15)$$

The angle $\gamma = BOA$ (Fig. 16).

Example of Short-center Belt Drive Calculations

Find the belt stresses, sectional area of belt, and effective weight K of the short-center belt drive represented by the

TABLE 3. TURNING FORCE (p), IN POUNDS, TRANSMITTED BY A LEATHER BELT HAVING A CROSS-SECTIONAL AREA OF ONE SQUARE INCH

Values for Medium Pulleys 14 to 36 Inches in Diameter*

Arc of Contact, Degrees	Velocity of Belt in Feet per Minute															
	400	700	1000	1300	1600	1900	2200	2500	2800	3100	3400	3700	4000	4300	4600	4900
180	150.2	163.0	173.5	181.5	188.7	192.7	197.5	200.0	202.2	204.0	203.5	202.0	200.4	198.5	196.00	192.50
184	152.5	165.2	175.7	183.7	190.6	194.8	199.3	201.9	204.0	205.6	205.0	203.4	201.2	199.1	196.50	192.70
188	154.8	167.5	177.9	185.9	192.5	196.9	201.1	203.8	205.8	207.2	206.5	204.8	202.1	199.7	197.00	192.90
192	157.1	169.7	180.0	188.0	194.5	199.0	203.1	205.6	207.5	208.8	208.2	206.1	203.1	200.5	197.60	193.10
196	159.3	171.8	182.0	190.0	196.6	201.0	205.2	207.3	209.0	210.7	209.6	207.3	204.3	201.4	198.10	193.30
200	161.5	174.0	184.0	192.0	198.7	203.0	207.2	209.0	210.6	212.5	211.0	208.5	205.5	202.3	198.60	193.50
204	163.4	176.2	186.0	194.2	200.6	204.6	209.0	210.7	212.2	213.8	212.1	209.7	206.3	203.1	199.00	193.70
208	165.3	178.4	188.0	196.4	202.5	206.2	210.7	212.3	213.8	215.0	213.2	210.9	207.1	203.8	199.40	193.90
212	167.4	180.6	190.0	198.4	204.4	208.0	212.4	214.0	215.3	216.2	214.2	212.0	207.9	204.5	199.80	194.10
216	169.5	182.7	192.0	200.2	206.2	209.9	214.0	215.5	216.6	217.4	215.2	212.8	208.7	205.1	200.10	194.30
220	171.5	184.7	194.0	202.0	208.0	211.7	215.5	216.9	218.0	218.7	216.2	213.7	209.5	205.7	200.50	194.50
224	173.3	186.5	195.8	203.8	209.8	213.4	217.1	218.3	219.4	220.0	217.2	214.6	210.3	206.2	201.00	194.70
228	175.1	188.3	197.6	205.6	211.6	215.1	218.6	219.7	220.7	221.3	218.1	215.5	211.1	206.7	201.40	194.90
232	176.9	190.0	199.3	207.4	213.3	216.7	220.2	221.3	222.0	222.6	219.1	216.4	211.8	207.3	201.65	195.04
236	178.8	191.7	200.9	209.2	214.9	218.1	221.7	222.7	223.3	223.7	220.3	217.2	212.4	207.9	201.80	195.12
240	180.7	193.3	202.5	211.0	216.5	219.5	223.3	224.2	224.8	224.8	221.2	218.0	213.0	208.5	202.00	195.20
244	182.5	195.2	204.3	212.6	217.9	221.1	224.5	225.3	225.8	225.6	222.2	218.9	213.7	208.8	202.40	195.28
248	184.1	197.2	206.1	214.2	219.3	222.7	225.7	226.4	226.9	226.4	223.1	219.8	214.4	209.1	202.80	195.36
252	185.9	199.0	207.7	215.8	220.8	224.2	226.9	227.6	228.1	227.3	224.1	220.6	215.0	209.6	203.20	195.44
256	187.6	200.5	209.1	217.4	222.3	225.6	228.0	228.7	229.0	228.1	224.9	221.3	215.5	210.1	203.50	195.52
260	189.2	202.0	210.5	219.0	223.7	227.0	229.2	229.8	229.9	229.0	225.7	222.0	216.0	210.5	203.70	195.60
264	190.7	203.6	212.1	220.6	225.2	228.2	230.4	231.2	231.0	229.9	226.5	222.6	216.5	211.0	204.00	195.68
268	192.2	205.2	213.7	222.2	226.7	229.4	231.6	232.3	232.0	230.6	227.2	223.2	217.0	211.5	204.35	195.76
272	193.9	206.8	215.4	223.7	228.2	230.7	232.9	233.6	233.3	231.5	228.0	223.9	217.6	212.0	204.60	195.84
276	195.6	208.5	217.2	225.1	229.6	232.2	234.3	234.9	234.3	232.5	229.0	224.7	218.3	212.5	204.80	195.92
280	197.4	210.2	219.0	226.5	231.0	233.9	235.7	236.2	235.5	233.5	230.0	225.5	219.0	213.0	205.00	196.00

Machinery

*This table is based upon a belt stress of 290 pounds per square inch of cross-sectional belt area.

TABLE 4. TURNING FORCE (p), IN POUNDS, TRANSMITTED BY A LEATHER BELT HAVING A CROSS-SECTIONAL AREA OF ONE SQUARE INCH

Values for Large Pulleys Over 36 Inches in Diameter*

Arc of Contact, Degrees	Velocity of Belt, in Feet per Minute															
	400	700	1000	1300	1600	1900	2200	2500	2800	3100	3400	3700	4000	4300	4600	4900
180	231.7	246.0	256.7	264.0	272.0	277.2	280.0	284.0	285.4	285.0	284.0	283.2	282.0	279.0	276.7	273.7
184	235.3	249.5	260.0	267.7	275.0	280.0	283.0	286.3	287.5	287.0	286.0	285.2	283.8	280.7	278.0	274.8
188	238.4	252.5	263.0	270.0	278.0	283.2	285.5	289.0	290.0	289.2	288.2	287.2	285.5	282.7	279.5	276.0
192	241.8	256.0	266.0	273.0	280.3	285.7	288.0	291.0	292.2	291.7	290.5	289.0	286.9	284.2	280.5	276.7
196	244.7	258.7	268.7	276.0	283.5	288.0	290.0	294.0	294.5	293.9	292.7	291.0	288.5	285.7	281.7	277.8
200	247.3	261.5	271.7	278.7	286.0	290.0	293.0	296.0	296.8	296.2	295.0	293.0	290.0	287.0	284.0	278.7
204	250.0	264.0	274.2	281.7	288.7	292.2	295.2	298.0	299.0	298.3	297.0	295.0	292.0	288.0	284.7	280.0
208	253.2	267.5	277.0	284.2	291.1	295.0	298.0	300.0	300.6	299.7	298.5	297.0	293.5	289.3	286.0	280.6
212	256.0	270.2	280.0	286.7	294.0	297.7	300.0	302.2	303.1	301.7	300.0	298.7	295.1	290.8	287.0	281.7
216	258.5	273.0	282.2	289.2	296.0	300.0	302.0	304.4	305.0	303.8	302.0	299.8	296.6	292.2	288.0	282.7
220	261.5	275.7	285.0	291.7	298.7	301.7	304.0	306.7	307.0	305.7	304.0	301.0	298.0	293.8	289.0	283.5
224	264.0	278.5	287.3	294.0	300.0	304.0	306.0	308.0	308.6	307.4	305.5	303.0	299.2	294.8	290.0	284.3
228	266.2	280.5	289.7	296.0	302.7	306.0	308.0	310.0	310.5	309.3	307.0	304.2	300.7	296.0	291.0	285.0
232	269.0	283.0	292.0	298.0	305.0	308.0	310.0	312.0	312.1	310.8	308.2	306.0	301.5	297.0	292.0	286.0
236	271.5	285.0	294.3	300.0	307.0	310.0	312.2	313.8	314.0	312.6	310.0	307.0	302.7	298.2	293.0	286.4
240	274.0	287.5	297.0	302.5	309.0	312.0	314.0	315.7	315.8	313.9	311.7	308.5	304.5	299.2	294.0	287.1
244	276.3	290.0	299.0	305.0	311.0	314.0	316.0	317.7	317.6	315.6	312.8	310.0	305.7	300.0	295.0	287.9
248	278.3	292.0	301.0	307.0	313.0	316.0	318.0	319.7	319.5	317.3	314.0	311.5	306.8	301.0	296.0	288.5
252	280.3	294.0	303.0	309.0	315.0	318.0	320.0	321.2	321.0	318.7	315.7	312.8	307.9	302.2	296.6	289.4
256	283.0	296.1	305.0	311.0	317.0	320.0	321.7	322.3	322.0	320.2	317.0	314.0	309.0	303.5	297.5	290.0
260	285.0	298.5	307.0	313.0	319.0	322.0	323.2	324.2	324.0	321.4	318.0	315.0	310.2	304.4	298.2	290.5
264	286.8	300.2	309.0	314.2	320.8	323.5	325.0	325.8	325.0	322.6	320.0	316.0	311.2	305.2	298.8	291.4
268	289.7	302.7	311.0	316.0	322.0	324.7	326.5	327.4	326.5	324.1	321.2	317.3	312.0	306.2	299.6	292.0
272	291.5	305.0	312.7	318.2	324.0	326.2	328.0	328.6	328.0	325.3	322.5	318.5	313.0	307.1	300.5	292.5
276	293.2	307.0	314.2	320.1	325.5	327.7	329.5	330.5	330.0	326.5	323.7	319.5	313.9	308.0	301.5	293.3
280	295.0	309.0	317.0	322.3	327.5	329.7	331.5	331.9	331.0	328.3	325.0	321.0	315.0	309.0	302.5	294.0

Machinery

*This table is based upon a belt stress of 395 pounds per square inch of cross-sectional belt area.

diagram Fig. 16. The belt is to transmit 250 horsepower at a speed of 3500 feet per minute.

The value of the turning or tangential force P, which must be exerted by the belt, is found by Equation (9) which becomes, by the substitution of numerical values:

$$P = \frac{250 \times 33{,}000}{3500} = 2357 \text{ pounds}$$

Equation (6) is used to determine the turning force which a belt having one square inch of sectional area will transmit. A value for S of 290 pounds is used for the 27-inch pulley which belongs to the medium class, and 395 pounds for the 67-inch pulley which belongs to the large class. The value of c is determined by using Equation (5) as follows:

$$c = 12\,\frac{0.038 \times 58.33^2}{32.2} = 48.1$$

The coefficient of friction is taken from Table 1 where we find that $\mu = 0.586$ for a medium pulley (27 inches in diameter) and a velocity of 3500 feet per minute; and 0.553 for a large pulley (67 inches in diameter).

The arc of contact between belt and pulley, according to Fig. 16, is 231 degrees on the 27-inch pulley (4.02 in radians), and 228 degrees on the 67-inch pulley (3.97 in radians). Therefore for the 27-inch pulley the turning force is:

$$p = (290 - 48.1)\,\frac{2.71828^{0.586 \times 4.02} - 1}{2.71828^{0.586 \times 4.02}} = 217.6 \text{ pounds}$$

and for the 67-inch pulley:

$$p = (395 - 48.1)\,\frac{2.71828^{0.553 \times 3.97} - 1}{2.71828^{0.553 \times 3.97}} = 306 \text{ pounds}$$

Since the calculation of p is very cumbersome, the tables which give these values for different velocities and arcs of contact will be found convenient.

By Equation (10) the cross-sectional area of the belt is determined. Thus

$$f = \frac{2357}{217.6} = 10.83$$

square inches for the 27-inch pulley.

$$f = \frac{2357}{306} = 7.7$$

square inches for the 67-inch pulley.

In determining the size of a belt, the greater value for the belt area must always be taken into consideration. The thickness d of the belt is found to be:

$$d = \frac{27 \times 0.15}{\sqrt[6]{290}} = 0.612$$

which is nearest to the 9/16-inch thickness of a triple belt. Therefore, by Equation (11) the belt width required is:

$$W = \frac{10.83}{0.5625} = 19.25$$

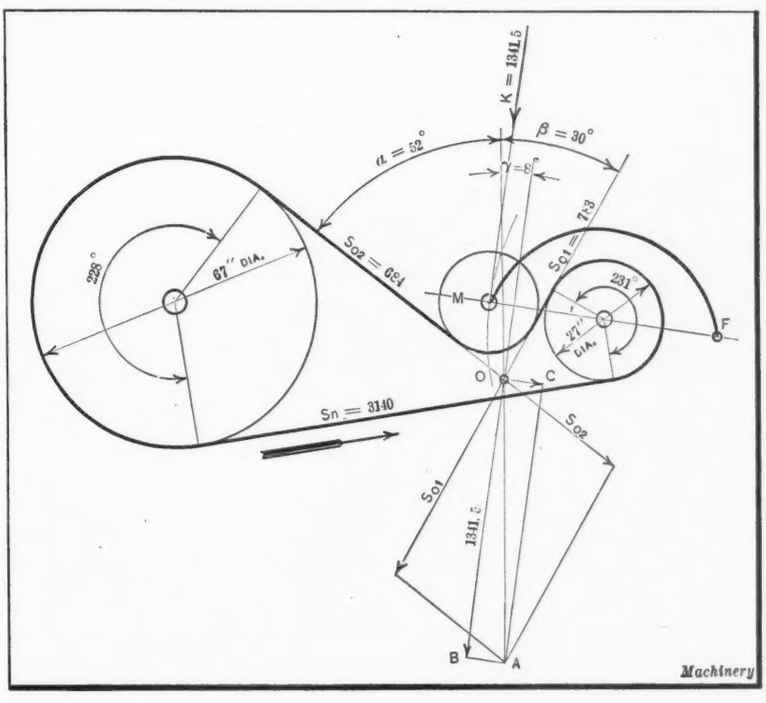


Fig. 16. Factors involved in determining the Effective Weight required on the Slack Strand of the Belt in order to produce the Necessary Tension

Thus we find that a triple leather belt, 20 inches wide and 9/16 inch thick, is required. The total tension in the tight strand of the belt is found by Equation (12) to be:

$S_n = 10.83 \times 290 = 3140.7$ pounds in relation to the 27-inch pulley; and $S_n = 7.7 \times 395 = 3041.5$ pounds in relation to the 67-inch pulley. The greater value of S_n has to be considered.

By Equation (13) we find the tension in the slack strand of the belt to be as follows:

$S_{o_1} = 3140 - 2357 = 783$ pounds in relation to the 27-inch pulley, and

$S_{o_2} = 3041 - 2357 = 684$ pounds in relation to the 67-inch pulley.

Either Equation (14) or (15) may be used for the calculation of the effective weight K. By Equation (15) this weight is determined as follows, using the angles found as previously explained in connection with the diagram Fig. 16:

$$K = 684 \times \frac{\sin 82^\circ}{\sin 30^\circ} \times \cos 8^\circ = 1341.5 \text{ pounds}$$

The third article of this series will deal with the design of tension rollers and their bearings, as well as other important details of the short-center drive.

* * *

HOW THE DEPARTMENT OF COMMERCE AIDS IN EXPORT TRADE

A committee to cooperate with the Department of Commerce in the furthering of the foreign trade of the machine tool industry was appointed some time ago by the National Machine Tool Builders' Association, with J. W. Carrel, vice-president and general manager of the Lodge & Shipley Machine Tool Co., Cincinnati, Ohio, as chairman. In a report of this committee, presented before the meeting of the National Machine Tool Builders' Association at Buffalo, it was stated that the figures of the Department of Commerce show that there is a considerable movement of machine tools abroad, and if machine tool builders were to make greater efforts to go after some of this business, this movement would be increased. The Department of Commerce can render such firms valuable service in different ways; it only remains for the machine tool builder to make use of the department. Those who have done so have been well repaid for their trouble.

The following are some of the ways in which the department can assist the individual manufacturer:

1. It is prepared to furnish information regarding the qualifications and limitations of all dealers in all foreign countries.

2. It can cooperate in handling advertising.

3. It is in position to furnish much information in regard to the general reliability and standing, etc., of individual foreign buyers. Should a foreign buyer or dealer become involved, the Bureau of Foreign Commerce can furnish information regarding legal and other methods that can be followed to protect American interests. It has assisted in settlement of claims and collection of accounts.

4. It has information regarding the amount of machine tool equipment imported into various countries, and the percentage of participation of American manufacturers in such trade.

5. It has frequently acted to establish contacts between American manufacturers who wish to handle export problems on a cooperative basis. It has assisted in establishing sales connections.

6. It can give expert advice on export packing, shipping problems, and tariff problems.

The department has almost no limit to the variety of its efforts, but it must await advice from the machine tool industry as to what specific things it can do to the advantage of the industry.

In a recent report, Mr. Rastall, chief of the Industrial Machinery Division of the bureau, points out that non-European markets have become much more important than they were in pre-war days. German competition, for the time being, is of little importance, and the trade of these territories is in the hands of British and American manufacturers. European designs originally represented less highly developed machines than those produced in this country, and could be offered at cheaper prices, so that if buyers in these markets are left to themselves it is most likely that they will purchase European tools because of price, regardless of quality. American machine tools must be sold through educational campaigns in these territories, and by constructive salesmanship in these markets to demonstrate that the American machine tool is superior and is worth the higher price that the American builder necessarily asks.

General-purpose tools should be well sold in non-European markets, and the statistics indicate this to be the case. In 1922, exports of industrial machinery were much above the year 1913, and with the improvement that is becoming evident in various localities, this increase should be maintained. The significant part of the 1922 figures, compared to 1913, is that the proportions of exports to Europe and Canada are less than two-thirds of the 1913 percentage. The proportion sent to Latin America is one-fifth greater, whereas the proportion sent to Asia is over five times as great as it was in 1913.

In dollar values, the exports to Europe and Canada have been reduced. Those to Australia and Africa have been maintained at approximately the same rate, whereas there was an increase from $19,000,000 to $28,000,000 in the value of exports to Latin America. The department estimates that the industry could sell at least $15,000,000 worth of American machine tools abroad each year. It is convinced that the present sales effort is entirely uneducated, and that the machine tool industry is losing an opportunity.

Under Mr. Hoover's administration, the Department of Commerce is now a real help to the manufacturer. Men who have not been assisted lately will not realize the difference in the attitude. Much information is cabled for—a service that was never before expected.

* * *

STANDARDIZED PLANER TOOLS

The production obtained from a planer depends to a great extent upon the cutting angles and shape of the planer tool. A roughing tool that is correct for steel, for example, will have too keen an edge for cast iron and will have a tendency to dig in, thereby producing chatter. The operator generally avoids this by cutting down the feed, thereby decreasing production, instead of trying to maintain production by using the right kind of tool.

The G. A. Gray Co., Cincinnati, Ohio, has recognized the necessity for establishing definitely the angles and shapes of tools most suitable for planer work, in order that the maximum production may be obtained from the planers manufactured by the company, and with this in view, has brought out a chart entitled "Cutting Tools Recommended for Use on Gray Planers." This chart, which is obtainable by application to the company, gives the proper shape, as well as the angles of rake and clearances on a set of sixteen different general-purpose tools, showing also the use for which each tool is intended.

To supplement this chart, the company also furnishes aluminum models which are numbered to correspond to the chart and have the various surfaces accurately ground. These models can be handed to the blacksmith, who, although he may not be able to read a drawing accurately, will, in forging the tool, be able to imitate the model, so that it can be quickly ground to shape. The chart and tool models were exhibited by the G. A. Gray Co. at the Railway Convention in Atlantic City, June 11 to 18. The use of a set of these models should save a considerable amount of time in planer work, thereby increasing production.

Chasing Lead-screws

Practice of the American Tool Works Co.

By CHARLES O. HERB

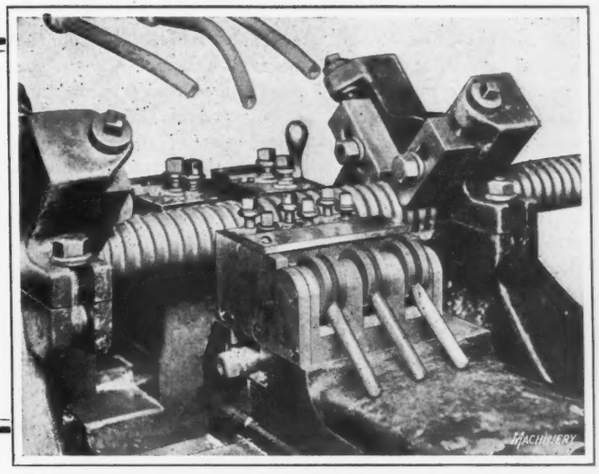


Fig. 1. Arrangement of the Tool-blocks and Follow-rests in cutting a Lathe Lead-screw

IN the early days of the lead-screw, the preliminary work of one mechanic, in chasing a screw, was to cut and fit paper around the previously turned cylinder, remove it, mark it with parallel oblique lines, replace it on the cylinder and prick the lines through it by means of a center punch. Then the paper was removed and the dots connected by fine lines made with a file, after which the alternate spaces between the lines were cut out with a chisel and hammer and filed smooth. A block of lead and tin was then cast around the partially formed screw. Adjustable cutters were mounted on this nut, and it was used as a sort of tool-holder slide-rest, being rotated around the screw by means of hand-levers to feed the cutters in finishing the thread. In other words, the thread was almost completely cut by hand and the nut used merely in finishing.

With such a crude method, the cost of a lead-screw would be prohibitive and its accuracy far beneath the standards of today, when the lead of a screw must be true between plus or minus 0.001 inch per foot. The accompanying illustrations show the method used at the American Tool Works Co., Cincinnati, Ohio, for cutting lead-screws within the limits mentioned. The particular operation shown consists of cutting a lead-screw 20 feet long and 2 inches in diameter with two Acme threads per inch. The swing of the lathe is 24 inches, and it is equipped with a 30-foot bed. There is a master lead-screw at both the front and back of the bed and also an apron on each side, so that cuts can be taken on the work with the carriage moving either to the right or left. The master lead-screw at the rear of the lathe can be rotated in either direction. It is used only for finishing.

On the carriage are mounted two tool-slides, the front one having both longitudinal and transverse adjustments and the rear one longitudinal only. On the front slide is mounted a block in which are contained three tools which are used for taking the same number of cuts at one time. Usually the first tool has a square nose for cutting the bottom of the thread, while the other two tools are ground at an angle of 29 degrees for cutting the sides of the threads.

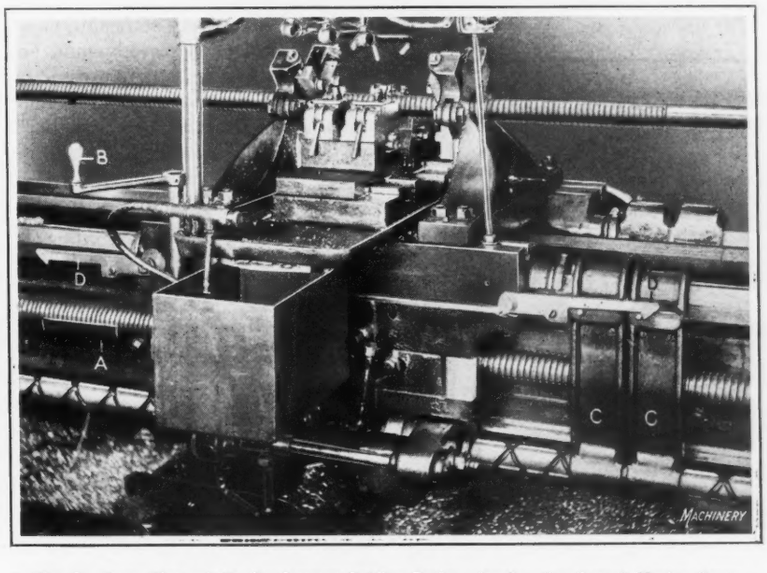


Fig. 2. Rear View of the Lead-screw Cutting Lathe, showing the Second Master Screw at the Rear of the Bed

These tools are brought into position for cutting by raising the handles of the cam-collars seen on the block in Fig. 1, which bear on the tools. When any of the handles is pulled back, a spring operates to withdraw the respective cutter from the work. This arrangement provides a convenient means of withdrawing each tool at the end of a thread so as to clear the work during the remaining forward movement of the carriage and during its return. Dovetail connections with the block prevent the tools from rising while under the cutting pressure. There are two similar blocks on the rear slide, as will be seen in Fig. 2. This arrangement of the tools provides for cutting threads on both the forward and return movements of the carriage.

In producing a lead-screw, it is first roughed out, semi-finished with the front lead-screw, and then allowed to season a certain length of time before it is finish-chased. The final cut is taken by a tool mounted in the front block which cuts only on the sides of the thread, the rear master screw being used to feed the carriage toward the headstock. The master screw at the rear is 2½ inches in diameter and it has two Acme threads per inch, left-hand. The main master screw from which this master screw is rechased as it becomes worn or from which other master screws are made to replace it, was made twenty-four years ago by the Brown & Sharpe Mfg. Co., and is still accurate within 0.001 inch in 4 feet.

In operations of this sort, it is imperative to support both the work and the master lead-screws rigidly. It will be seen that on each side of the tool-blocks there is mounted a sturdy follow-rest equipped with jaws that bear on the outside diameter of the work. Steadyrests are also located along the length of the bed. The master screws are supported by means of brackets *A*, Fig. 2, which are spaced at intervals of about 1½ feet along the bed. The brackets are open on top to permit the carriage half-nuts to engage the lead-screw. The half-nuts of the rear apron are closed on

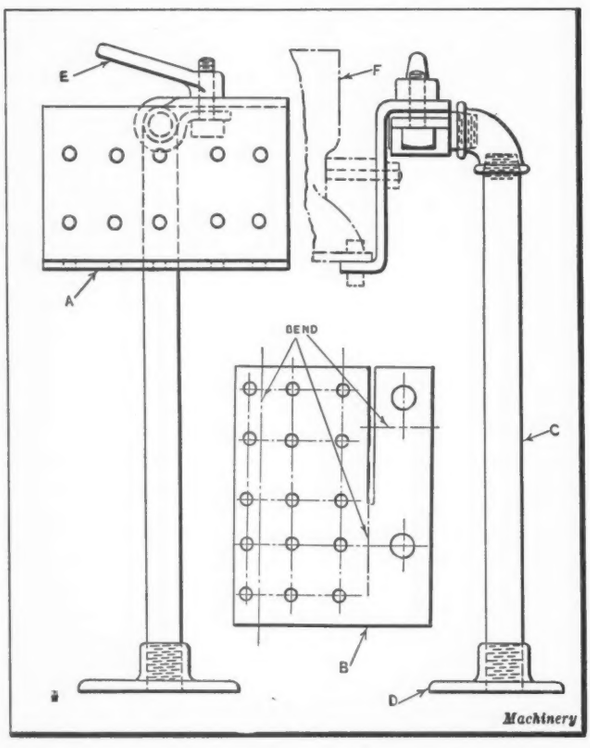
the screw by moving lever *B* which functions through a slide provided with cam slots to actuate studs connected with the half-nuts. There are also two pairs of supports *C* on each side of the bed for the rapid-traverse screws, these supports being pulled along with the carriage by means of latches *D* until the latches are released as they strike trip-locks. The latch on the left-hand side of the carriage, as seen in Fig. 2, pulls one pair of supports after it when the carriage is fed toward the headstock, while the latch on the right-hand side drags the other pair of supports when the carriage is being fed in the opposite direction. No close estimate of the time involved in producing lead-screws can be given, as this varies widely with the individual screws. In making this part, accuracy is the most important consideration, and the time factor is a minor one.

* * *

WORK-STAND OF SIMPLE CONSTRUCTION

By G. A. LUERS

Mechanics who have had experience in handling large units or parts of automobiles, such as engine blocks and transmission cases, know how difficult it is to hold them on the bench in a convenient position for fitting bearings



Swiveling Stand for holding Engine Cylinder Blocks and Similar Work

or performing the various operations required in repair work. A swiveling stand, such as is here illustrated is needed for work of this kind. This stand is inexpensive and can be easily constructed. It is provided with a bolting plate *A*, made from ⅜-inch steel. This plate is provided with a series of holes which permit hook or strap bolts to be used for clamping the work in place.

In making plate *A*, the sheet steel is first cut to the shape indicated in the view at *B*, after which it is bent on the dotted lines, as indicated. The remaining part of the stand is composed principally of pipe fittings. The plate *A* is clamped to the short section of pipe which is fitted to the elbow at the upper end of the vertical piece of pipe *C*. The vertical pipe is secured to the floor by means of a pipe flange *D*. The lever *E* is employed to clamp the work-holding plate at any desired angle. The method of holding a cylinder block on the plate is shown by the dot-and-dash lines at *F*.

INTERCHANGE OF IDEAS

By J. R. HENDERSON

Are there any lasting advantages to be derived by a firm adopting a policy of secrecy in regard to methods and devices developed in the plant for production work?

Undoubtedly there are many shops that use unique and highly efficient methods, which are essential factors in the successful operation of the shop. On the other hand, there are a great many shops that carefully guard so-called "shop secrets" to the detriment of their own progress. The belief that they are in possession of a highly efficient secret process often blinds the executives of such firms to the possibility that competitors may already know of the features they are so anxious to conceal, or may be using still more highly developed methods.

Individuals also often guard "trade secrets" as their stock in trade. Many men are apparently impressed with the thought that they monopolize all the good ideas, and that the development of new ideas, together with their practical application, could not materialize in other minds. Often a man becomes so possessed with the value of his own ideas that he is incapable of accepting suggestions from others, and in such cases he often becomes the greatest obstacle in his own path of advancement.

The following incident relating to a trade secret carefully guarded in a shop may prove of interest. A certain attachment was developed from designs suggested by the superintendent of the plant for making certain sheet-metal products. Considerable experimenting was required before the machine could be successfully operated. For some time after it was put in service, it created much interest among the workmen in the shop, several of whom, in the course of time, operated it, each man becoming more or less familiar with its construction and operation. When outside visitors, presumably competitors, were shown around the shop, however, instructions were issued beforehand and forwarded to the foreman, so that when the visitors were passing through the department the machine was "idle" and the shop secret hidden from view by means of a cover.

About two years after the new machine had been put into operation, this hiding process was inadvertently neglected when a visitor passed through the shop. With the "secret" detected, the visitor was asked to comment upon its action, and rather surprised the superintendent by replying that a similar device had been working in another shop for some years, but that several improvements of a more recent origin had greatly increased its efficiency. The visitor's suggestions were carefully noted, and subsequent changes were made in the device that resulted in greater production and improved quality of the product.

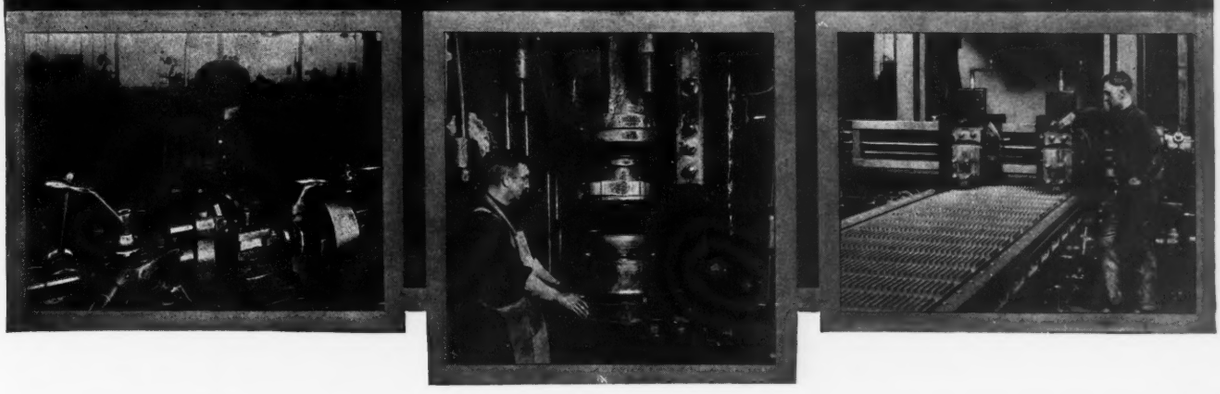
Few, if any, of us are so original in our ideas that we can afford to be entirely self-contained. If the truth were really known, most shop secrets could be traced to previous ideas or suggestions verbally expressed or obtained from technical journals or books—creations of another mind. Surely, then, if we are willing to accept another's suggestions from which we may profit, we should be willing to reciprocate in so far as we are able. Interchange of thoughts and ideas has been the means by which all really worthwhile mechanical progress has been made. The mythical value of shop secrets is daily becoming more and more appreciated. Reciprocity is recognized as one of the factors of progress. A leader still will remain a leader even though he is willing to share his knowledge with others. Let us remember Kipling's words:

"They copied all they could follow,
But they couldn't copy my mind,
And I left them swearing and stealing,
A year and a half behind."

* * *

One of the indications of the growth of the automobile industry is that the Society of Automotive Engineers has at the present time over 5400 members.

Letters on Practical Subjects



TURNING AND GRADUATING A SPHERE

Among the various things of a special nature that are occasionally made in a machine shop there is probably nothing that is more attractive to the eye than a nicely turned and polished metal ball or sphere. It is difficult, however, to turn a true or perfect sphere, especially if the diameter is greater than 8 or 10 inches. Spheres of this size are not in the field of regular production work in the average shop, yet nearly every machine shop has machine tool equipment that may be arranged for accurately turning spherical work of this size. In Figs. 1 and 2 are shown lathe set-ups employed in turning a bronze sphere 9¼ inches in diameter.

Spherical turning involves the provision of some adequate means for holding the work and proper tool equipment for turning the metal. In this particular case, the turned and polished bronze sphere is made in two parts, and is graduated as shown in Fig. 3. The major part *A* has walls about ¼ inch thick. The other part, which consists of a removable cover *B*, is threaded to fit the threaded opening in the larger part *A*. Both parts of the sphere are made from bronze castings. In Fig. 1 the casting for the major part is shown clamped to a faceplate on an engine lathe in readiness for the first step in the turning operations. The equipment for this set-up includes the lathe faceplate and a ring *C* which is doweled to the faceplate. After ring *C* has been properly located and doweled in place, a cut is taken on the inner surface in order to bring it concentric with the lathe spindle, so that the sphere will run true when clamped in place by the retaining ring *D*.

The spherical casting is, of course, adjusted so that the aperture to be threaded runs true or is concentric with the lathe spindle. The aperture is bored out and threaded to fit the special steel holder *E*. The diameter of the thread is 6¼ inches, and there are 11 threads per inch. Both the retaining ring and the holder were made from pieces taken from the scrap pile. The small pilot at the upper end of the holder serves to center the sphere for the turning operation, which is illustrated in Fig. 2. At the opposite or rear end of the spherical casting, there is an internal hub about 2½ inches long which is bored to fit the ⅞-inch pilot on the end of holder *E*, Fig. 1. The end of this hub is faced so that when the sphere is screwed on the holder, the face of the hub will bear evenly against the collar on the holder. The work must, of course, be screwed on the holder tight enough to prevent it from being loosened by the pressure exerted by the turning tool. The shank, thread, and pilot end of the holder *E* must all be concentric.

Referring to Fig. 2, it will be noticed that the holder is gripped in the lathe chuck jaws. This lathe has a sufficiently large swing to permit the use of a regular milling machine turntable as a means of supporting and imparting the required movement to the turning tool. The surface of the turntable is accurately located in a horizontal plane which is parallel with the axis of the lathe spindle. The axial center of the table must also be located on a vertical center line which passes through the axis of the lathe spindle. If the table is not accurately located with respect to the lathe spindle an accurate sphere cannot be produced. When the center of rotation of the table is nearer the front, or operator's side, of the lathe, the work will be turned to a spheroid shape, and when the center of the table is located back of the center of the lathe spindle, an ellipsoid will be produced. It is possible, therefore, to produce irregular forms of the type mentioned. The cutting point of

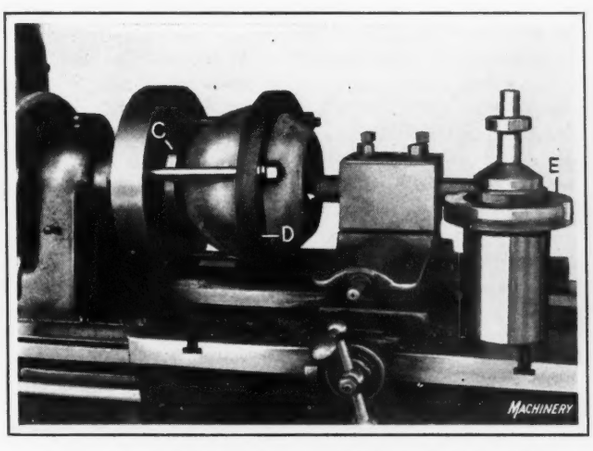


Fig. 1. Preliminary Operation in machining a Spherical Casting

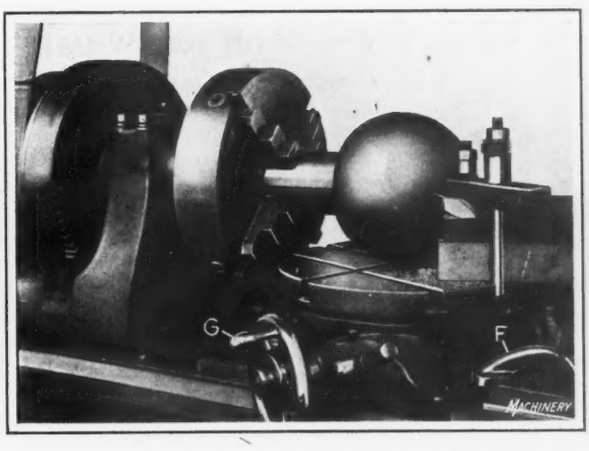


Fig. 2. Lathe Set-up employed in turning a Sphere

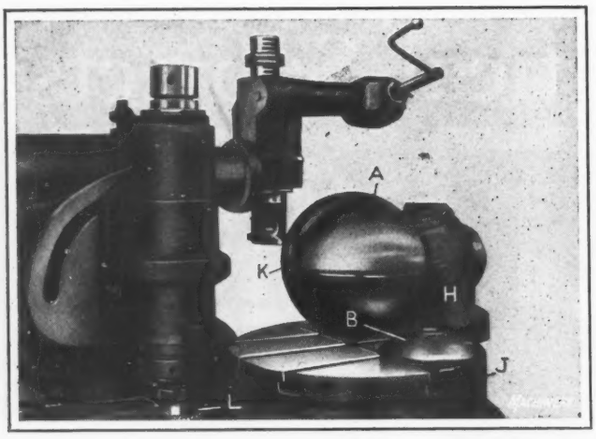


Fig. 3. Milling Machine Set-up used in grooving and graduating a Sphere

the tool should, of course, be accurately set for height, that is, it should be at the same height as the center of the lathe spindle.

It will be noted that the turntable rests on the ways of the lathe, and is securely held in place by two C-clamps, one of which is shown at *F*. The carriage of the lathe is brought up against the turntable and wedged in place in such a manner as to support the table and thus add to its rigidity. The turning tool and the manner in which it is held on the turntable are clearly shown in the illustration. The turntable is rotated by means of the handwheel *G*, while a hammer is employed to drive the tool into the metal for each successive cut. It was found that three cuts were required to complete the turning of the sphere. A slight brushing of the work with a file and final polishing with emery cloth gave the work a fine appearance, as will be evident by referring to Fig. 3. It should be mentioned that the work-holder was carefully trued up in the chuck before the turning operations were performed.

Following the turning and polishing operations, the work-holder with the work still in place is transferred to the holder *H* attached to the turntable *J*, which is mounted on a milling machine. A 1/8-inch slot, 3/32 inch deep, is cut part way around the sphere at *K* with a milling cutter *L*, after which the work is graduated for a little more than a half-circle, or about 190 degrees. The graduating cutter attached to the overhead arm of the milling machine was illustrated and described on page 379 of January MACHINERY. The correct spacing of the graduations was obtained by indexing the turntable by means of the handwheel. The cover *B* was finished in the same manner as the sphere, except that it was held on a special fixture having a concave end while being turned to the required size.

Springfield, Vt. O. S. MARSHALL

ROLLING THREADS ON SCREW CAPS

An article on thread rolling which appeared recently in MACHINERY prompted the writer to submit the following information regarding the shape of thread which he has found best suited for rolling threads on screw caps. As an example, let it be required to design a pair of threading rolls for rolling the thread on a screw cap for a glass jar. The glass jar has five threads per inch, and the outside diameter over the thread is 3 inches. The inside diameter of the plain shell or cap before the thread is rolled is therefore 3 inches also, and the cap should just pass over the outside of the threaded end of the jar. Screw caps for jars of this kind are usually made a loose fit, as one turn of the cap on the jar is sufficient to produce an air-tight joint. There are, of course, instances in which more than one turn may be required, but one turn will usually be found satisfactory.

The outside diameter of the thread on the roller must be made about ⅛ inch smaller than the inside diameter of the plain shell, because the rolling operation forces some of the metal to the top or outside of the thread and some of the metal to the bottom or inside of the thread. As this decreases the inside diameter of the threaded shell, it is evident that an allowance must be made in the diameter of the roll which will permit the work to be withdrawn from the roll. A clearance of about ⅛ inch between the inside diameter of the shell and the roll is sufficient for screw caps having fine threads which are to fit cold-cream jars and similar containers. For fruit jars, however, the procedure would be slightly different, as a closer fitting thread is required. Instead of having the plain shell pass over the threads on the jar, its inside diameter should be about 1/32 to 3/64 inch smaller than the outside diameter of the threads on the jar. Screw caps made in this way will require several turns before they are set up tight.

Assuming that the diameter of the inside threading roll has been determined to be 2⅞ inches and that a 5-pitch thread is to be used, we find, in the table accompanying Fig. 1, that the single depth for the roller should be 0.100 inch, and that the radius of the tool should be 0.050 inch. In other words, for a 5-pitch thread, we divide the pitch, in inches, by 2 to obtain the single depth of the thread. Thus, 0.200 divided by 2 equals 0.100. In order to obtain the radius *R* of the tool, we simply divide 0.200 by 4, which gives us 0.050 inch.

The general shape of the thread on the threading roll made according to the specifications given is shown in Fig. 2, and the threads rolled with this roller will have the shape shown in Fig. 3. The threads on the work are somewhat shallower than the threads on the rollers, due to the fact that no allowance is made for the thickness of the stock when making the inside and outside rollers. In rolling a thread, the rollers are simply adjusted to the depth of thread necessary to obtain the desired fit. Caps threaded

THREADING TOOL DIMENSIONS

Threads per Inch	Single Depth D, Inch	Radius of Tool R, Inch
8	0.0625	0.0312
7	0.0715	0.0357
6	0.0833	0.0416
5	0.100	0.050
4	0.125	0.0625
3	0.1666	0.0833

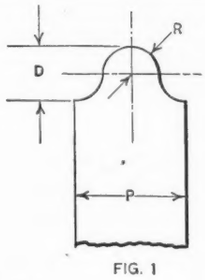


FIG. 1

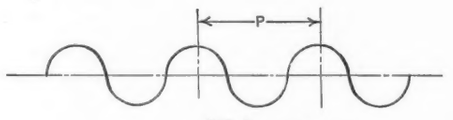


FIG. 2

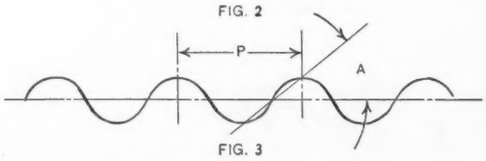


FIG. 3

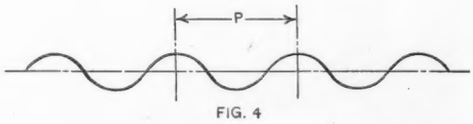


FIG. 4

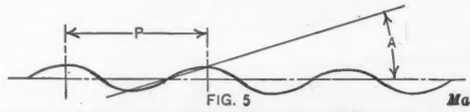


FIG. 5

Machinery

Figs. 1 to 5. Threading Tool, and Correct and Incorrect Forms of Thread

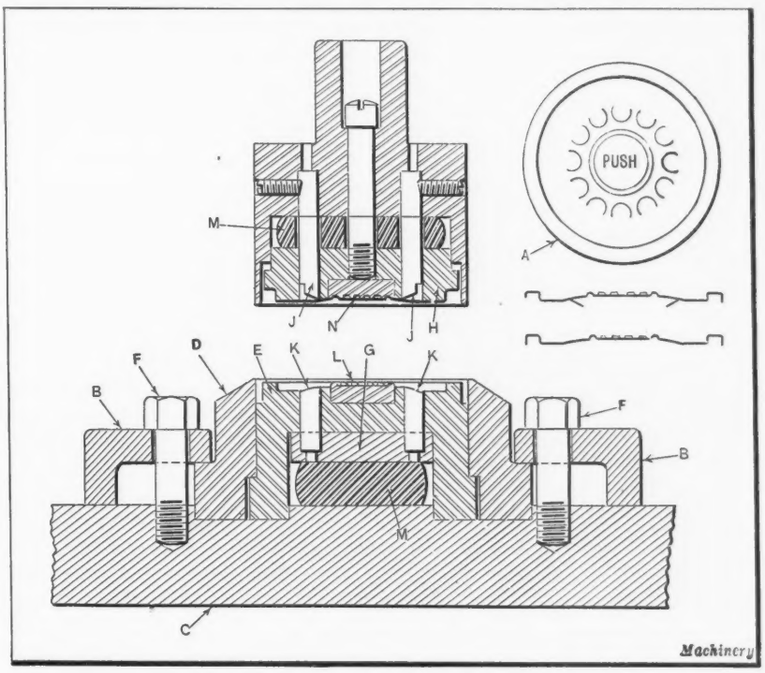
as shown in Fig. 3, which have quite a wide thread angle, such as indicated at *A*, will not stick or become "frozen" to the jar.

If the profile of the threads on a threading roller is as shown in Fig. 4, the resulting thread on the screw cap will have the form shown in Fig. 5. A cap made with a shallow thread angle, such as shown in this view, will always stick to the jar when screwed on tight. This sticking is due to the wedge-like or shallow thread angle *A*. The inconveniences caused by the sticking of screw caps may be remedied, however, by providing the caps with deeper threads, so that the thread angle will be as indicated in Fig. 3.

Brooklyn, N. Y. EDWARD J. RANTSCH

COMBINATION DIE FOR CAN TOP

The combination die has been developed during the last two decades from the successful experiment of the skilled diemaker to a standardized tool that is now extensively used by manufacturers of sheet-metal products. The combination or number of operations performed in one die has been increased, and the parts have been simplified to such an extent that it is no longer necessary to depend upon the skill of one diemaker for the production of a complete die of this type. Thus it is now common practice to design a complete combination die on paper and to have the detail drawings made from an accurate lay-out of the design. Blueprints of these detail drawings can be distributed to the different machine departments for the actual production of the die parts with the assurance that the parts can be assembled with very little hand-fitting.



Combination Die used in producing the Can Top shown at A

The shaker can top *A* shown in the upper right-hand corner of the accompanying illustration is produced on the combination die shown in the sectional views. While the operations of blanking, forming, shearing, closing, and lettering are all performed at one stroke of this die, it is nevertheless of simple construction. With the exception of the die-clamps *B*, all the machine work is performed in the lathe, drilling machine, and cylindrical grinding machine. The bench work consists principally of reaming and tapping. The shoe *C* is made from a cast-iron plate which is machined in the lathe. The recess and the boss for locating the blanking or cutting die *D* and the die center *E* are turned at the same time that the facing operation is performed. This completes the die-shoe with the exception of drilling the hold-down holes and the holes for the clamping studs *F*.

The cutting part *D* of the die is made from tool-steel bar stock, which is cut off a little longer than the finished part so that the die can be chucked and the turning operations completed at one setting. The absence of bolt holes in die *D* eliminates to a considerable extent the danger of cracking when the part is hardened. It will be noted that the clamps *B* hold down both the cutting part *D* of the die and the die center *E*. The parts of the die that are finished by grinding are so located in the chuck that all the grinding operations can be performed at one setting, thus insuring the concentricity of the various surfaces.

The holes in the die center *E*, punch *H* and pad *G* are drilled and reamed with the parts assembled, the holes for the punches *J* and pins *K* being located from the center of the die. The contour of the die center *E* and the pad *L*, as well as the punch *H* and pad *N*, are made to fit gages which are stored away for use in making renewals. The punches and the die-pins are made from a standard size of drill rod so that renewals can be quickly made. Rubber pads *M* are used instead of springs, as the movement of the die parts is very short. Lettering pads *N* and *L* are a tight fit in the punch *H* and the die center *E*, respectively.

The die operates as follows: When the punch comes down it cuts out the blank, after which the punch pad forms the contour and draws down the edges of the blank over the die center. As the punch continues downward, the rubber-pads *M* are compressed, so that the piercing punches *J* project through the pad *H* and shear the sprinkler openings. The lower pins *K* are, of course, pushed down when the openings are sheared. Finally, as the punch reaches the end of the stroke, the punch pad and the die center come together solidly on the work, thus bringing the lettering out in sharp relief. As the punch ascends, the lower pins *K* force the lugs in the work back into their respective openings so that they are closed. As the press is inclined, the can tops slide off the die as soon as the punch clears the work. Can tops of the type illustrated are not opened in the usual way, by pushing the lugs down, but by depressing the center of the cover so that the lugs really project outward.

Brooklyn, N. Y. S. A. MCDONALD

MILLING HELIX ON PUNCH END TO OBTAIN SHEARING ACTION

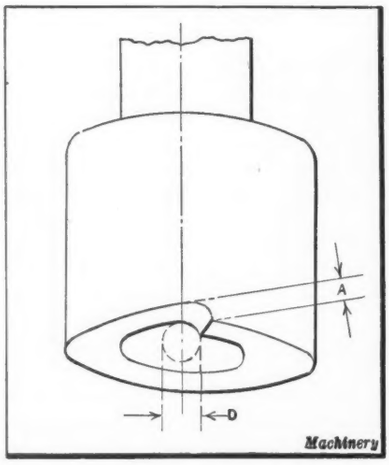
The method employed in milling the end of the punch shown in the accompanying illustration may seem rather unmechanical, but nevertheless it proved sufficiently accurate to meet all the requirements for this particular part. The end of the punch was to be milled to a helical form having a lead *A* of ⅛ inch in order to obtain the required shearing action. The punch, which has an outside diameter of 2½ inches, was centered in the chuck of a dividing head mounted on a milling machine table, and an end-mill having a diameter indicated by dimension *D* used for milling the helix.

It was necessary to index or rotate the work by hand, since such a small lead as ⅛ inch could not be obtained by gearing the indexing head to the table feed-screw with any of the gears available. The table feed-screw having a lead of ¼ inch would, of course, make one-half revolution in advancing ⅛ inch. Therefore, in order to obtain the desired lead, it was necessary that the index-crank make 40 complete turns while the handwheel secured to the table

feed-screw made one-half revolution. The high speed at which the index-crank was turned by hand, as compared with the much slower movement of the table, resulted in a very even cut.

The correct ratio between the rotary speed of the work and its longitudinal travel may be gaged quite accurately by counting the turns of the index-crank while watching the rotating handwheel. For instance, let it be assumed that the total number of turns of the index-crank required to obtain the desired lead is 40, and that the handwheel is required to make only one-half revolution. Now when the handwheel has completed one-quarter of its total movement, or one-eighth of a complete rev olution, the index-crank should have made 10 revolutions. If the operator finds that he has turned the index-crank completely around only eight times, he knows that he must increase the speed during the next one-eighth revolution of the handwheel to 12 revolutions in order to make up the loss which occurred during the first one-eighth revolution of the wheel. It is, of course, an easy matter to estimate the one-eighth revolution of the handwheel, but if the best results are to be obtained, it is suggested that division marks be made with chalk on the handwheel. By noting the fractional movements of the handwheel and gaging the speed of the index-crank to correspond, it is possible to obtain fairly accurate results.

Fitchburg, Mass. E. E. LAKSO



Punch with Helical Shaped End

FIXTURE FOR REBORING LATHE TAILSTOCKS

The plant where the writer is employed, like a great many others having several hundred lathes in continuous operation on production work, was faced with the problem of reboring worn out tailstock spindles. Until the fixture shown in the illustration was developed, considerable time and money was spent in handling this repair work. In boring out the tailstocks, it had been the practice to set up the entire bed of the machine on a boring mill so that the headstock spindle of the lathe could be lined up with the tailstock. With the fixture shown, the regular lathe spindle drive and the carriage feeding mechanism are used in performing the reboring operation. This not only insures a very satisfactory job, but also saves time that would otherwise be spent in taking down the lathe and placing it on the boring mill.

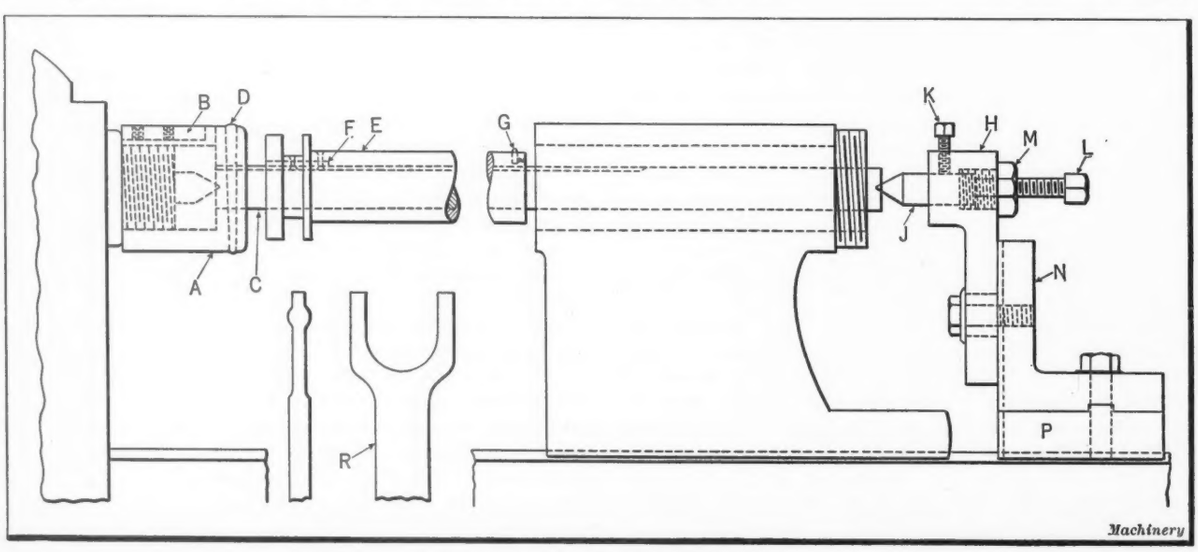
The fixture is provided with an adapter *A*, which slips over the top of the thread on the end of the headstock spindle and is held in place by tightening two set-screws against a movable brass shoe *B*, which prevents the thread of the spindle from being marred. Shaft *C* is about 1 inch in diameter, 20 inches long and has a ¼-inch keyway cut in one end for a distance of 9½ inches. This shaft is driven by a taper pin *D* which passes through the adapter.

The cast-iron sleeve *E* is 2½ inches in diameter at the driver end and 1¾ inches in diameter at the body part. This sleeve is about 10 inches long and is fitted with a ¼-inch key *F* which is a sliding fit in the keyway cut in shaft *C*. The tool bit *G* is held securely in place at one end of the sleeve by means of a small set-screw. The cast-iron bracket *H* is provided with an adjustable center *J*, which is held firmly in place, after being properly adjusted by tightening the set-screw *K*. Set-screw *L* is employed in adjusting the center, and is locked in place by the nut *M*, so that it serves to back up the center. Bracket *H* is adjustable for height on the knee *N* which is secured to the cast-iron plate *P* in such a manner that it can be adjusted sidewise or in a direction at right angles to the axis of the lathe spindle. Plate *P* is fitted to the ways of the lathe, and is held down by a bolt in the same way that the tailstock is secured to the lathe ways.

In setting up the fixture on a lathe, it is necessary to first remove the tailstock. The plate *P* is then secured to the bed of the machine, about 20 inches from the headstock spindle center. Shaft *C* is next mounted between the centers of the lathe spindle and the fixture, after which it is carefully lined up with the aid of an indicator secured to the toolpost of the lathe carriage. When the indicator shows that the shaft is properly trued up, the bracket *H*, knee *N* and plate *P* are secured in place. Shaft *C* is then removed, and the tailstock clamped to the lathe bed.

The adapter *D* is secured to the lathe spindle and the shaft *C* with the collar *E* in place is inserted through the tailstock and secured between the centers. The taper pin *D* is then put in place and the set-screws tightened down on the brass shoe *B*. The driver *R* is mounted in the toolpost of the lathe carriage in such a way that the forked end is located in the groove cut in sleeve *E*. After adjusting the tool bit to take the right depth of cut, the lathe is started and the carriage feed employed to move the collar through the hole in the tailstock. It is understood that a new tailstock spindle must be made after a lathe tailstock has been bored out as described.

Cleveland, Ohio WILLIAM WILSON

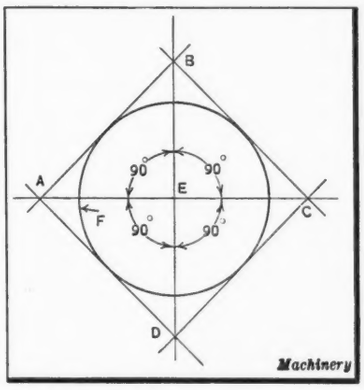


Set-up used in reboring Lathe Tailstock

Shop and Drafting-room Kinks

LOCATING THE CENTER OF A CIRCLE

Occasionally a draftsman finds it necessary to locate the center of a circle. A convenient and quick method of doing this is described in the following: Referring to the accompanying illustration, we have given a circle *F*, the center of which is to be found. First, using a 45-degree triangle, draw lines *AB* and *DC* tangent to the circle and parallel to each other. Next draw lines *AD* and *BC* tangent to the circle and perpendicular to lines *AB* and *DC*. Finally draw line *AC* and *BD* through the intersections of the lines already drawn, as indicated. The center of the circle will be located at the point of intersection *E* of lines *AC* and *BD*.

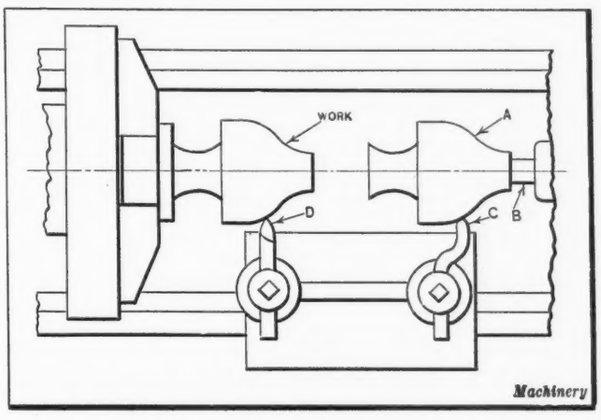


Quick Method of locating Center of a Circle

Lansing, Mich. C. F. POWERS

TURNING IRREGULAR SHAPED WORK

The turning of irregular shaped work having curved surfaces requires considerable skill on the part of the lathe operator. Curves of large radii are not as readily turned as small curves which can be produced by special tools ground to the required radius. In fact, work having a curve of a large radius cannot be turned with any degree of accuracy unless some special turning device is used.



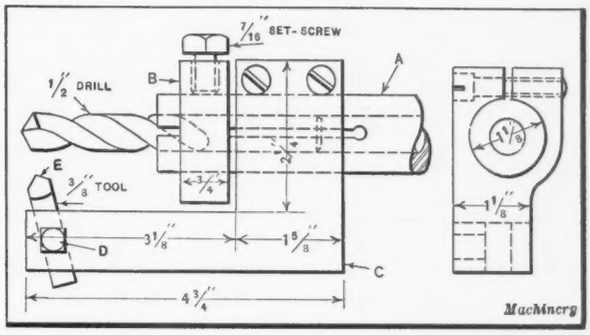
Method of using Master Guide for turning Irregular Shaped Work

The accompanying diagram shows the principle employed by one company in setting up a regular engine lathe for radius and irregular form turning. This method is used for quantity production work. Briefly, it consists in providing a duplicate *A* of the part to be turned which is used as a guide, or master, in turning the work. The part used as the guide or master is mounted on a shank *B* held in the lathe tailstock. A dummy blunt-end tool *C* is placed in the tool-rest, in addition to the cutting tool *D*. It is then a simple matter to keep the dummy in contact with the master *A* by means of the lathe controls so that the work being turned will be an exact duplicate of the master *A*.

Washington, D. C. G. A. LUERS

COMBINATION TOOL-HOLDER FOR SCREW MACHINE

A combination drill and turning-tool holder which the writer made up for use on an Acme multiple-spindle automatic screw machine is shown in the accompanying illustration. This holder has given excellent results when used for simultaneous turning and drilling operations. The shank *A* of the holder is 1⅛ inches in diameter and 9 inches long. A hole extends completely through this bar, and is a good fit for the ½-inch drill. It will be noted that the front end of the holder is slotted and that a collar *B*, provided with a set-screw, is used to clamp the drill in place. The tool-holder *C* is clamped to shank *A* by two fillister-head



Combination Tool and Drill Holder for Screw Machine

machine screws, as shown in the end view. A 5/16-inch set-screw *D* serves to hold the turning tool *E* in place.

New Britain, Conn. JOHN LARSON

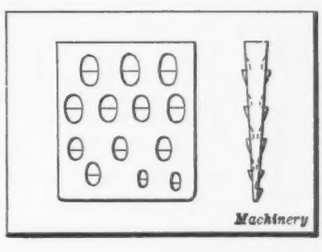
PROVIDING CLEARANCE FOR ADJUSTABLE THREADING DIES

In making adjustable threading dies having three or more cutting segments or parts, it is always best to cut the thread in the solid die before it is divided into segments. The thread should be smaller than the desired size so as to give the cutting edges of the die segments plenty of clearance when they are adjusted to cut the standard size thread. For instance, in making a ⅝-inch threading die, the diameter of the thread cut in the solid die material should be 9/16 inch. This will give the desired clearance to the thread cutting segments when the die is adjusted to cut the standard ⅝-inch thread.

Denver, Col. R. M. THOMAS

WEDGE FOR HAMMER HEAD

A steel wedge that has been found very satisfactory for holding hammer heads on their wooden handles is shown in the accompanying illustration. Instead of having smooth sides, this wedge has projecting barbs on each side, which are made with a punch. It will be evident from the illustration that these barbs readily permit the wedge to be driven in place, but prevent it from loosening or being easily withdrawn.



Wedge for expanding Handle in Hammer Head

FLOYD GRAVES
Ypsilanti, Mich.

Questions and Answers

STRAIGHT OR TAPERED DOWEL-PINS?

O. C. H.—Is the use of straight dowel-pins or tapered dowel-pins considered the better or more common practice in the making of built-up or sectional dies for power presses?

This question is submitted to MACHINERY'S readers.

DRAWING DEEP SQUARE SHAPES

R. C. M.—What has been done in regard to designing and constructing dies for the deep drawing of square and rectangular shapes? The problem at hand involves drawing a 5- by 5-inch part, having a depth of 12 inches. The thickness of the stock is to be 0.025 or 0.030 inch.

This interesting problem in die work is submitted to MACHINERY'S readers.

METHOD OF CONSTRUCTING A TANGENT ARC

L. S. K.—In making a drawing of a tool, it was found necessary to construct an arc that would pass through two points K and L and also be tangent to a certain line at P,

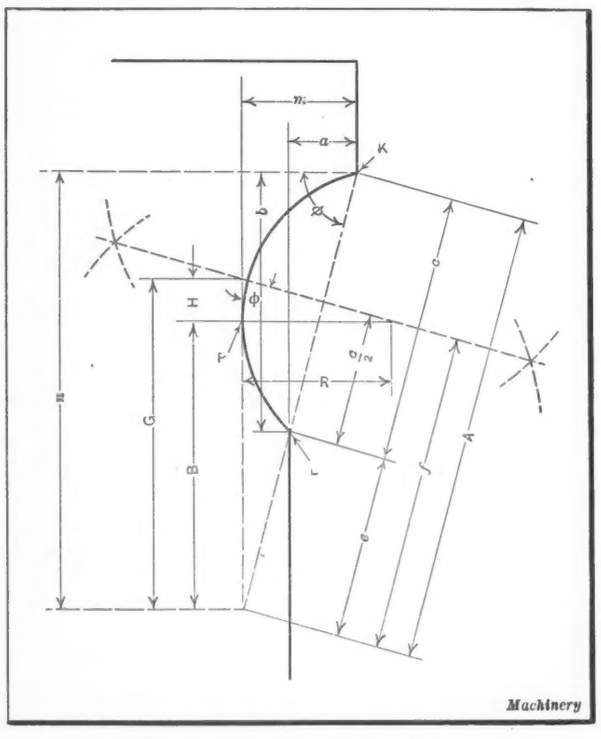


Diagram used to illustrate Method of drawing Tangent Arc

as shown in the illustration. The dimensions a, m, and b are known, and R is the radius to be found. Will you please show how to construct the required arc?

ANSWERED BY J. HOMEWOOD, ONTARIO, CAL.

First draw a line connecting the two points K and L and then erect a perpendicular at the middle point of this line. It is now evident that the center of a circle having the required radius R must be located somewhere on the perpendicular line. According to geometry, dimension B is the mean proportional between A and e, which means that $A:B::B:e$. We also have the ratio $a:m::b:n$.

By geometry we have $A = \sqrt{m^2 + n^2}$ and by trigonometry we have $\cos \phi = \frac{m}{A}$. Now,

$$f = \frac{C}{2} + e \text{ and } G = f \div \sin \phi$$

As B is the mean proportional between A and e, we have $B = \sqrt{Ae}$.

By subtraction, $H = G - B$.

Now according to trigonometry,

$$R = H \times \tan \phi$$

LEAD COATING STAMPINGS

A. H. H.—What is the most economical method of lead coating small articles made from hot-rolled strip? After punching, the parts are pickled, dipped in a flux, and then immersed in hot metal consisting of two parts lead to one part tin. We cannot get a clean finish, because the scum from the top of the metal adheres to the articles.

ANSWERED BY W. W. TOPPING, SOUND BEACH, CONN.

If about ½ inch of powdered charcoal is kept on top of the melted lead and the stampings are plunged through the charcoal, the scum will not interfere with the lead coating.

ANSWERED BY A. E.

The alloy referred to in the question submitted in April MACHINERY—two parts lead and one part tin—is an expensive mixture to use for lead-coating purposes, because of the high percentage of tin. More economical lead-coating alloys are given in the accompanying table, together with their approximate melting points.

Lead, Per Cent	Tin, Per Cent	Melting Point, Degrees C.
95	5	315
90	10	303
85	15	290
80	20	278
75	25	266
70	30	255

The best lead-coating mixtures are made from pure lead and pure tin, both of which can be obtained in commercial quantities at market prices. Zinc, even when present in very small quantities, has an injurious effect on lead-tin alloys, interfering with the coating properties and leaving a rough surface.

From time to time many supposed alloys of lead and tin have been described for various purposes, but only that with 63 per cent tin, corresponding to the formula $Pb\ Sn_3$, can be considered a definite chemical alloy. It solidifies at 178 degrees C. and melts at 183 degrees C., the melting point being raised by addition of either of the component metals. This alloy is far too expensive for coating metals, when lead coating answers the purpose.

In melting lead and tin scrap metals, oxides are formed, and some of these are likely to become entangled in the molten metal, causing it to become thick; to remedy this, vigorous stirring with a charred stick is necessary in order to bring the scum or dross to the surface. The tendency of lead-tin alloys to thicken depends upon the length of exposure to the oxygen of the atmosphere and upon the area exposed. A large area naturally forms more scum or dross than a small one, so that in melting a certain quantity of lead and tin, a deep narrow pot is preferable to a wide shallow one. It is also observed that the tendency to thicken is much greater when the melting pot is nearly empty, and the metal may become so thick as to run pasty.

Thick metal, which is due to entangled oxide, may be purified by reducing the oxide by means of charcoal, care being taken to prevent the metal from becoming too hot, as the rapidity of oxidation increases with the temperature. Stirring the thick metal, when molten, with a stick of green wood answers the same purpose; the wood, however, must be pushed to the bottom. The gases liberated by the charring of the wood greatly assist in bringing the scum or dross to the surface. Raw bones in place of wood is sometimes used, but the odor evolved is objectionable. It is also necessary to place on the surface of the molten metal a layer of tallow, which melts and covers the surface, thus protecting it from the action of the oxygen of the air. When dross in large quantities has to be treated for the reduction of the oxides, a reverberatory furnace is the most economical; but with small quantities a crucible furnace is the best, especially as a crucible is a deep and comparatively narrow vessel, and therefore offers the minimum exposure to the atmosphere, and the maximum facility for the reducing agents to bring the metal to a metallic state.

The process of lead coating resembles in many respects that of tinning or galvanizing. The articles are lead coated to protect them from rust, and in the case of iron and steel sheets, when lead coated, are more readily soldered. The more expensive process of tinning has the same object, but lead-coated articles are not suitable for cooking purposes, and they have not the high luster of tin.

ANSWERED BY "MET"

In the query concerning lead coating small articles published in April MACHINERY, A. H. H. mentions articles made from "hot-rolled strip," but does not state whether the strip is ferrous or non-ferrous metal. As both steel and 60/40 brass are hot-rolled, for example, it is impossible to decide which strip is referred to, and therefore some remarks concerning both may be of interest and value.

In both cases, absolute cleanliness is the first essential for obtaining good results, and in some respects the process is similar to ordinary commercial soldering, when, as is well known, a good joint depends almost entirely upon the chemical cleanliness of the metallic surfaces, the solder, and the soldering bit. The articles in question should, therefore, never be handled after they have been pickled, because in this way they may be covered with a very slight trace of grease, which is sufficient to prevent the lead alloy from adhering to the metallic surfaces.

The prevention of lead dross forming on the surface of the molten lead is not a very difficult matter. Actually, of course, this dross consists of oxides of lead and tin which are formed by the direct combination of the molten metal with atmospheric oxygen. To prevent this combination, therefore, it is necessary to protect the surface of the metal, as far as possible, from the atmosphere; but as this cannot be done completely it is also necessary periodically to flux the metal to rid it of dissolved and suspended oxides. One of the best fluxes for this purpose is solid zinc chloride, which may be purchased in sticks of about the size of an ordinary pencil. If pieces of this substance, about one inch long, are vigorously stirred into the molten metal it will efficiently flux it, and most, if not all, of the dross will rise to the surface of the metal, where it can be skimmed off.

It is, perhaps, not generally known that metallic iron also helps to keep molten lead or solder free from oxides, and so the container for the metal is best made of iron or steel. Clean pieces of iron or steel should be suspended in the metal; broken hacksaw blades or old files are excellent for this purpose, but they must be clean and bright, because dirty or rusty iron has no beneficial effect on the metal. It should also be borne in mind that the higher the temperature to which the metal is heated the more will it tend to oxidize, and for this reason the temperature should be kept as low as possible; it should never exhibit a visible red color; that is, a temperature of about 950 degrees F. must not be exceeded.

After the metal has been fluxed with zinc chloride and the dross skimmed off, the surface should be covered with small wood charcoal to prevent it from oxidizing again. If the charcoal is skimmed to one side just prior to dipping the articles into it, a clean coating of lead should result, which should be quite free from dross.

As mentioned, absolute cleanliness of the molten metal and the metallic article is the key to success in employing this process.

ANSWERED BY "A"

The Schoop metal spraying, coating, or metallizing process is by far the most satisfactory method to use for lead coating stampings, and is relatively economical. By this method a protective or decorative surface may be applied to iron, steel, brasses, wood, plaster, and even paper, and coatings of practically all commercial metals and alloys may be applied to any desired thickness irrespective of size, character, and shape of the pieces to be treated. The process embraces the melting and atomizing of the coating metal or alloy, which is in wire form, and impinging it as a fine spray on the surface to be protected.

The nozzle of the spraying pistol is held at a distance of 5 to 6 inches from the work, and a singular point in connection with this process is that the metal is not applied in the molten state. Actually the gaseous medium is so much larger in volume than the drop of metal reduced to powder, that the expanding gas cools the metallic spray before it strikes the surface to be coated. The heat of collision, however, causes the particles to vaporize and condense on the relatively cold surface and thus form a homogeneous coating. Besides the union of the projected particles themselves, the first ones to strike the surface are driven into the pores. A granular surface is thus produced, having a sand-blasted appearance, and although there is no tendency to flake during the regular polishing operations, polishing is not recommended.

The metal spraying process is quite a simple one and eliminates the necessity of preheating the metal. Pickling is often omitted, but to insure first-class results the parts for treatment may be sand-blasted if a suitable installation exists, and it may be noted that the sand-blasted surface is ideal for deposition by spraying. The operation is an exceptionally short one and supersedes galvanizing, electro-deposition, and tinning. Tin, lead, zinc, copper, and aluminum are the metals most readily sprayed, and, apart from electro-deposition, this is the only method of providing a steel coating.

HOW CAN BLUEPRINTS BE MADE TO ADHERE TO CELLULOID?

H. J. H.—If any reader of MACHINERY has been successful in developing a method for making blueprints adhere to celluloid, a detailed description of this method would be appreciated. The writer has tried glue, but when it dries it does not adhere to the celluloid. Shellac, when dry, cracks and also makes the celluloid curl.

ANSWERED BY E. T. SMITH, CHIEF DRAFTSMAN, CHAPMAN VALVE MFG. CO., INDIAN ORCHARD, MASS.

We attach blueprints of our telephone numbers to celluloid in the following manner: First the blueprints are placed between two thin sheets of celluloid, and then the celluloid sheets are put between heated plates until they are sufficiently hot for the two sheets to adhere to each other. The adhesion of the sheets is so perfect as to appear like a single sheet, and the blueprint is protected on both sides.

ANSWERED BY "HILLSIDE"

A method of mounting blueprints on celluloid that we have used with success is to saturate the surface of the celluloid with wood alcohol, then place it on the blueprint, and hold it flat by a heavy book until dry. This causes the celluloid to adhere firmly to the blueprint.

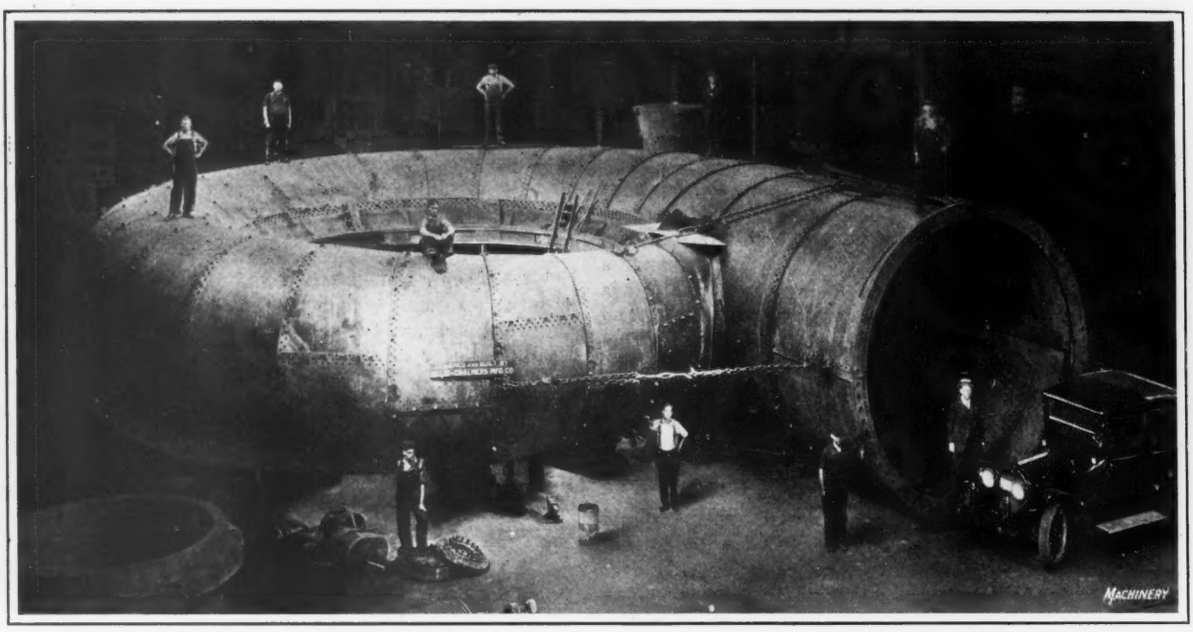


Fig. 1. Plate-steel Spiral Casing for 70,000-horsepower Hydraulic Turbine, having an Inlet Diameter of 15 Feet, built in the Allis-Chalmers Mfg. Co's Plant

Building Huge Hydro-electric Machinery

AT the present time there are being installed at Niagara Falls three of the largest water turbines and electric generators that have ever been built. The hydraulic turbines are of 70,000 horsepower each, working under a 213-foot head of water and making 107 revolutions per minute. The generators are 65,000 K.V.A., 12,000 volts, 25 cycles, of the vertical type. One of these hydraulic turbines and one of the generators are being built at the plant of the Allis-Chalmers Mfg. Co., Milwaukee, Wis., where the photographs here shown were taken. These illustrations are of especial interest because they show the enormous proportions of the parts required for this huge installation, and indicate the nature of the problems that had to be solved by the engineers in connection with the machining and assembling of these huge pieces of machinery.

Fig. 1 shows the completed plate-steel spiral casing for the turbine. The inlet diameter of this casing is 15 feet, the plate thickness varies from ⅞ inch to 1¼ inches, and the over-all diameter of the casing is 50 feet. Fig. 2 shows the casing under construction with the speed ring of the

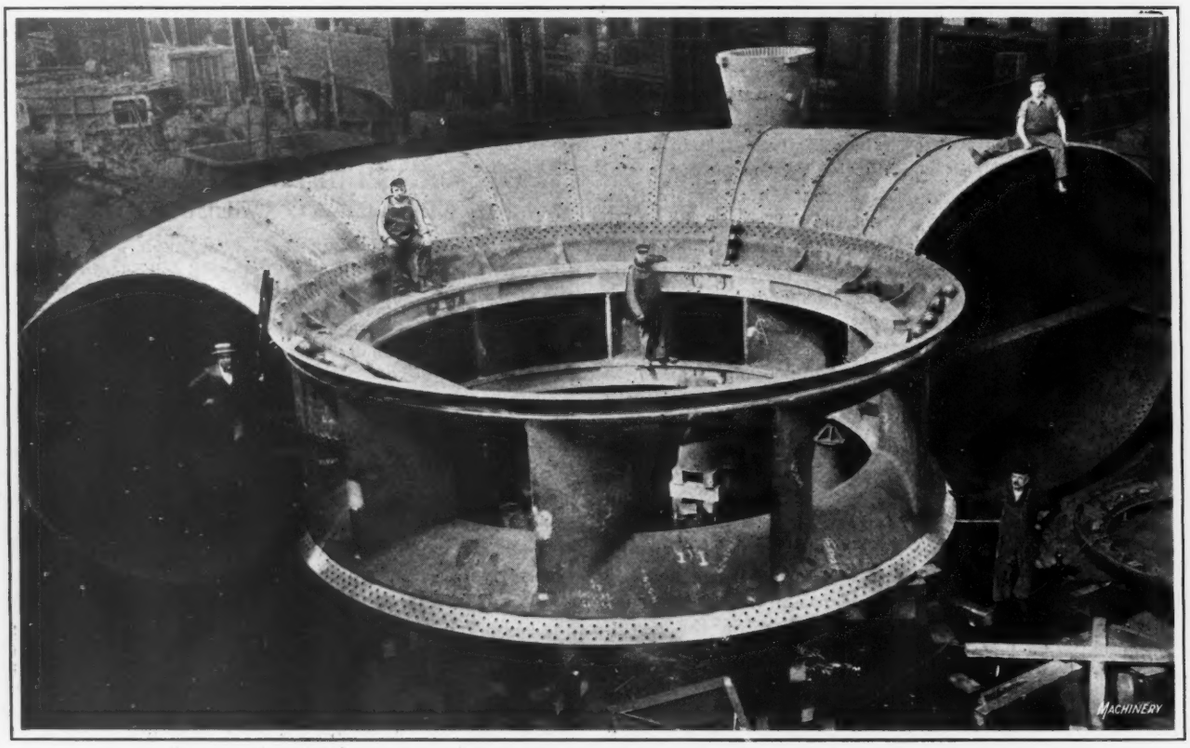


Fig. 2. Spiral Casing for Hydraulic Turbine under Construction, together with Speed Ring of Turbine. The Total Weight of the Speed Ring alone is over 70 Tons, the Outside Diameter being 26 Feet and the Bore 20 Feet

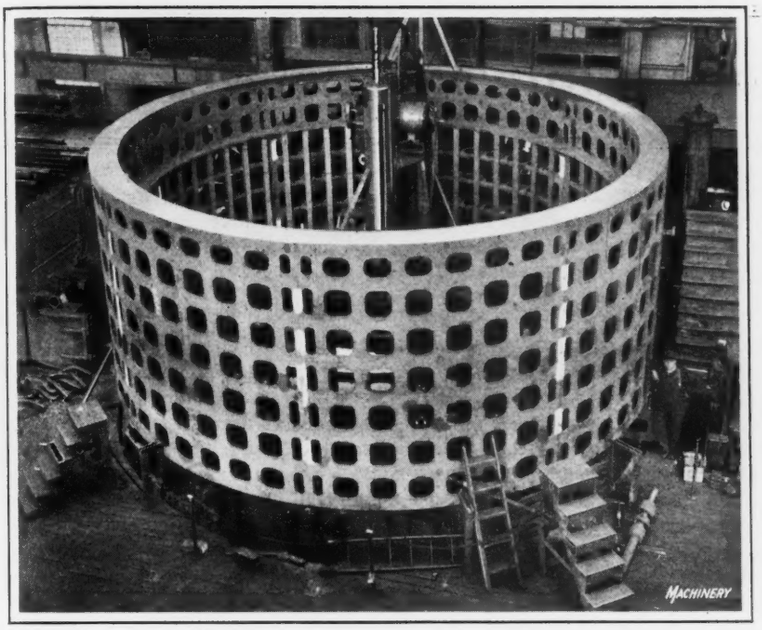


Fig. 3. Machining the Large Generator Stator Yoke for a 65,000 K.V.A. Hydro-electric Unit

turbine in front. The speed ring is made in five sections, and has a total weight of over 70 tons, with an outside diameter of 26 feet, and a bore of 20 feet.

Fig. 3 shows the stator yoke of the 65,000 K.V.A. vertical generator as set up for machining the inside and facing the top of the huge assembled casting. Within the casting, there is a 16-foot Niles boring mill with the housings and cross-rail removed. The stator was located on parallels with the boring mill table in the center. On this table was mounted a slotter provided with special tool-carrying heads and driving motors mounted in place. By this method it was possible to bore and face the stator complete and also to perform the slotting operations.

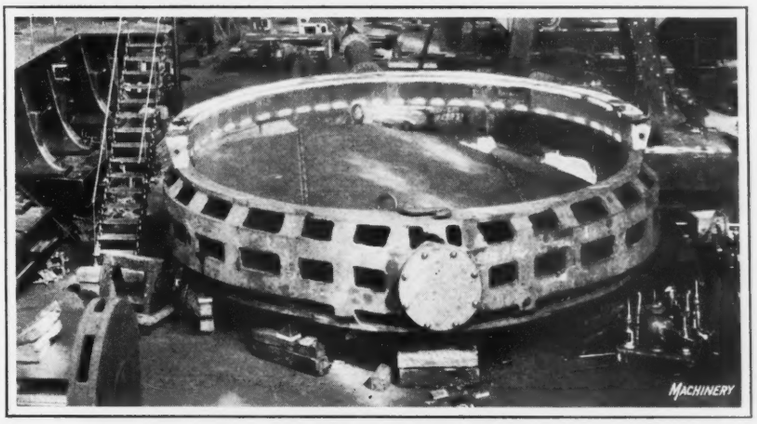


Fig. 4. The Assembled Butterfly Valve, with Wicket and Operating Shaft

Fig. 5 shows the housing of the butterfly valve used in connection with the hydraulic turbines. This housing is 23½ feet in diameter and weighs 50 tons. The assembled valve with housing, wicket, and operating shaft is shown in Fig. 4.

To men accustomed to small machining work, such as met with in the ordinary manufacturing plant, the machining of these huge castings presents problems that seem almost impossible of solution; yet they have been successfully solved by the different companies that have been engaged in the building of the three complete power units for the Niagara Falls Power Co. While problems of this kind occur so seldom that a detailed description of how the work is performed would be of no special benefit, the mere fact that work of this kind can be performed is of considerable interest.

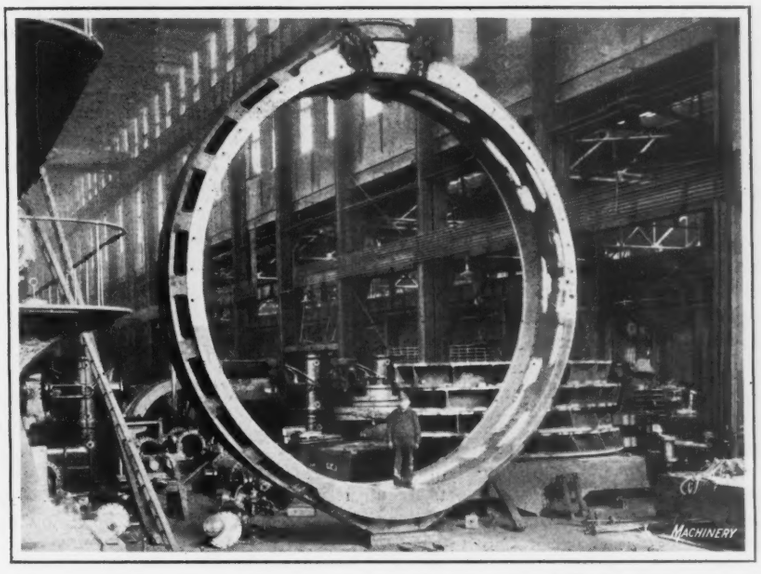


Fig. 5. The Butterfly Valve Housing, 23½ Feet in Diameter, and weighing 50 Tons, which is used for the Niagara Falls Hydraulic Turbines

MEETING OF A. S. M. E. VERMONT SECTION

What is known as the Green Mountain Section of the American Society of Mechanical Engineers, including members of the society located in Vermont and western New Hampshire, met at Windsor, Vt., June 6, with Professor Edward Robinson, head of the Department of Mechanical Engineering at the University of Vermont, and chairman of the Green Mountain Section, presiding at the meeting. Professor Emeritus Lester P. Breckenridge, of the Sheffield Scientific School of Yale University, spoke on "What the Mechanical Engineer can do for Vermont." He emphasized the fact that the future of engineering enterprises in Vermont is assured by the ample water power resources available, which make possible the promotion of decentralized industries provided with cheap power from hydro-electric power stations. He said he was convinced that in this part of the country power will not flow from a huge central station to the ends of outlying arms, but will rather be fed into the outlying arms by small automatic power plants on mountain streams. James Hartness, president of the Jones & Lamson Machine Co., and ex-governor of Vermont, gave his views on the work of the Green Mountain Section. Other speakers were Ralph E. Flanders, manager of the Jones & Lamson Machine Co., and Henri A. Sevigne, general manager of the National Bread Wrapping Machine Co. A report on the spring meeting was presented by Guy Hubbard of the National Acme Co., Windsor, Vt., who was elected chairman of the section.

The Machine-building Industries

IS it a fact or merely a myth that business is always poor in presidential years? We know that business in 1924, so far, is not so good as it was in 1923; but we also know that business is a great deal better than it was in 1921 and 1922. Whenever the railroads are prosperous and come into the market with big orders, business generally is good, because the railroads consume a large percentage of the production of the basic industries—30 per cent of the production of the iron and steel industry alone. Hence, one of the most interesting facts brought to light in connection with studies of business conditions in past presidential years relates to the railroad field, and shows that railway purchases in the past have been greater in presidential years since 1911, than in the years preceding them.

In each of the years 1912, 1916, and 1920, the number of locomotives and cars put in service by the railroads exceeded the number bought during the previous year. This will not hold true for 1924 for the simple reason that purchases in 1923 were of a record-breaking character, surpassed only in 1912; but it is well to know that presidential years in the past have not been notoriously poor years in the railroad equipment field; and it is reasonable to assume that the railroads were not buying great quantities of new equipment if they had no freight to carry, nor were the industries of the country at a standstill with great quantities of freight to be hauled.

Railroad Purchases Indicate Faith in the Future

Railroads representing 96 per cent of the mileage of the country authorized during the first three months of 1924 expenditures for permanent improvements and equipment aggregating $766,000,000. These appropriations are larger than for any year in the last ten, except 1923; so it is clear that whatever may be the general opinion about the future of business, there is no serious apprehension in the minds of those who control our railroads. In spite of the fact that the equipment of the roads is in an unusually good condition—both freight and passenger service not having been so satisfactory as it is now for some twenty years past—the railroads are still continuing to order additional freight cars, having added over 46,000 during the first four months of the year, with an additional 68,000 on order. Over 750 locomotives were added in the same time, with 550 still on order.

These figures are mentioned simply to indicate the accuracy of the statement of the Federal Reserve Bank of Cleveland that business sentiment, while naturally influenced by certain unfavorable developments in the business structure, "as usual is depending more upon hearsay and undigested statistics for guidance than upon actual facts, and is traveling well in advance of the present recession. The needs, both actual and potential, of more than one hundred million consumers in this country are seldom given proper recognition. These needs are just as keen as ever, and while the work of supplying them may be held in abeyance for a time it cannot be stopped for any long period." This, after all, is the basic fact in all industrial activities.

The same report points out that ultimate consumption continues at a high rate, reports from fifty-seven department stores in fourteen different cities showing an increase in net sales for the first four months in 1924 over the corresponding period last year.

On the other hand, no business man can afford to be blind to the fact that there has been a decrease in production in a great many industries, the declines being particularly large in the iron and steel, automobile, and textile fields. The total decrease in production, however, for April—the last month for which complete statistics are now available—was only 2 per cent, factory employment declining also 2 per cent during that month.

The Machine Tool Industry

Any decline in production in the general industrial fields, even though the percentage be small, immediately affects the machine tool industry to a marked degree, and as a result machine tool orders in May decreased from previous months and there is probability of a comparatively slack demand during the summer months. There is no industrial expansion, and consequently no demand for new equipment in new plants. Undoubtedly there is great need for the replacement of obsolete equipment, but whenever there is the slightest contraction in business, expenditures for machine shop equipment are among the first to be curtailed. Except for the hesitancy due to doubts concerning the future, every other factor in the financial and industrial structure is favorable to expanding business. Low interest rates might be expected to make industrial financing easier, and labor is plentiful, although proportionately higher wages than in the past are the rule. These high labor costs, however, constitute a good argument for the use of labor-saving machinery. Materials in the machine-building field are plentiful, and prices are at a reasonable level. The transportation system is capable of handling freight with unusual dispatch. Hence, practically all the industrial factors are favorable to a normal business.

But even a normal business will not fill the machine tool plants of the country to capacity. The expansion during the war years was too great for any normal peace demands, and only as some of the present shop capacity is gradually diverted to other uses, will it be possible for the machine tool industry to return to what will again be normal and satisfactory conditions.

Congress having adjourned without passing any of the two-hundred odd bills introduced to restrict, in one way or another, the activities of the railroads and to reduce their earnings, it is likely that the railroad managements will continue their program of expansion with greater confidence, and that there will be more shop equipment bought for the railroad shops than during the earlier months of the year. The opinions expressed at the convention of railroad men in Atlantic City, in conjunction with which there was an unusually large and complete machine tool exhibit, indicated that the mechanical executives of the railroads are eager to place modern machinery in their shops.

The Automotive Industry

The May production of automobiles and trucks, as estimated by the National Automobile Chamber of Commerce, was 301,200. This production, while showing an appreciable decline from the figures for April, must, nevertheless, be considered fully normal. The indications are that the total for the year will reach about three million cars and trucks, and even the most optimistic would not expect that this country could absorb more than that number when the market has been practically saturated, as it now is.

The following, from the survey of business by the Federal Reserve Bank of Cleveland, tersely summarizes the business situation: "While the present hesitating attitude which generally prevails throughout the country forbids more active business at this time, it also refuses to be turned into a serious reaction, and this resistance indicates the soundness of underlying conditions."

New Machinery and Tools

The Complete Monthly Record of New Metal-working Machinery

Cleveland Multiple-spindle Automatic

EXPERIENCE with automatic screw machines has led to the conclusion that there are certain jobs that can be more profitably handled on single-spindle machines, while others demand the multiple-spindle type for high rates of output. Because of this fact the Cleveland Automatic Machine Co., Cleveland, Ohio, has developed as an addition to its line of single-spindle automatics, the four-spindle machine here illustrated, which enables the company to supply either type of machine, depending upon the job.

In working out the design of this new machine, certain features of the Cleveland Model *A* single-spindle automatic have been incorporated, such as the location and style of cams, etc. As a result, any operator accustomed to operating the single-spindle machine will find no difficulty in handling the multiple-spindle type. With the exception of threading tools, the auxiliary tooling equipment is interchangeable between the single- and the multiple-spindle machines. This is advantageous in shops in which both types of machines are installed, as it not only simplifies the problem of handling tools, but also effects an economy through reducing the investment and keeping the tools more constantly employed than would otherwise be the case.

All cams and adjustments have been so located that they can be easily seen and reached by the operator. Cams of different pitches and lengths can be used on the turret drum for handling pieces of various lengths. On the ⅞-inch size, 5 inches is the maximum milling length, but work up to 7 inches in length can be handled when the milling stroke does not exceed 3½ inches. When the work is of such a character that threading is not required, a simplified machine can be furnished without any threading mechanism. The chips and cutting oil drop through the bed into the pan where they cannot interfere with the mechanism.

Arrangement of the Drive

To meet the requirements of different shops, the automatic can be arranged for either single-pulley or motor drive. With the single-pulley drive, the pulley is 3 inches wide and the diameter 22 inches, and with the electric drive, a five-horsepower motor running at 1750 revolutions per minute is employed. The motor is attached to a baseplate bolted to the machine, and power is transmitted from it by a chain.

The spindles are driven from a center shaft through hardened helical gears, seven speed changes being provided by means of change-gears. A new type of compression collar and balanced chuck operating finger is used. The chuck opening and closing slide is operated direct from cams on drum *A* on the camshaft without levers, this combination providing a simple and efficient mechanism. Each chuck hood is covered by an individual cast-iron guard to protect it and prevent cutting oil from being thrown around when the spindles are running at high speed. The front spindle bearings consist of bronze sleeves attached to the spindles and running in adjustable hardened and ground steel bear ings. There is a similar construction for the rear spindle bearings except that no adjustment is provided. End thrust is taken by ball bearings located in front of the rear spindle bearings, adjusting nuts being provided at the rear end of the spindle cylinder.

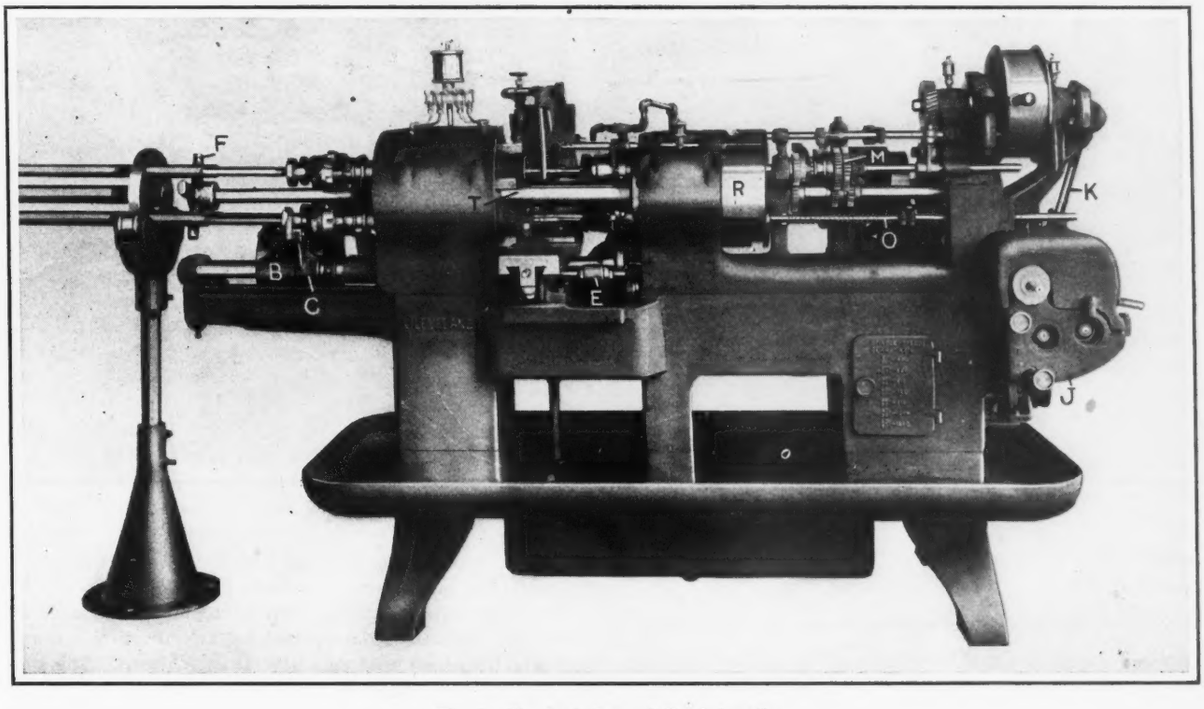


Fig. 1. Cleveland Four-spindle Automatic

Arrangement of the Stock Feed

Two slides *B* and *C* operate the feed-tubes, and these slides are controlled direct from cams on drum *D* without any intermediate levers. The camming is so arranged that the tubes are always picked up by the feed-slide, regardless of their longitudinal position. Spring action is utilized for feeding the stock. The gage-stop *E* swings up to meet the bar stock as it is fed outward, and then drops out of the way. This stop is mounted on a bar, supported at both ends and threaded to permit length adjustment of the stop, and its operation is controlled by an independent cam. The reel stock tubes are provided with bushings to suit the diameter of the stock being handled. The reel is rotated by means of a driver *F*, carried on a bar attached to the rear end of the spindle cylinder.

The spindle indexing mechanism consists of a Geneva movement which engages the cylinder at *G* between the spindle bearings. Locking is accomplished by a heavy flat wedge operated by the indexing arm *H*. A hand-lever may be attached for withdrawing the wedge so as to permit the spindle turret to be rotated by hand in setting up and changing chucks.

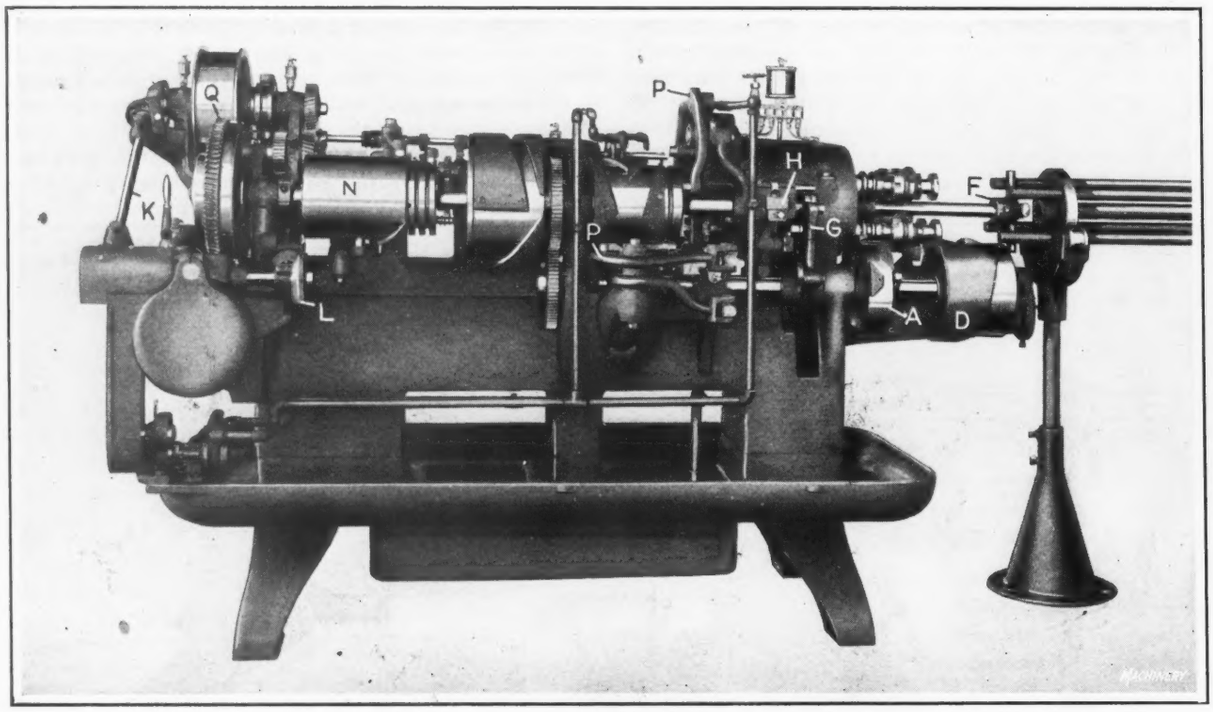


Fig. 2. Rear View of the Cleveland Multiple-spindle Automatic

Tool Feed Mechanism and Positioning of Tools

Gear-box *J* provides ten speed changes, any one of which is instantly available. The idle movements of the tools are constant, being driven direct from the pulley through shaft *K*. Power is transmitted to the feed mechanism by the center shaft and thence through gears at *L*. By this arrangement the selected feed per spindle revolution remains constant for any given spindle speed. The oil-pump is driven by chain from a constant-speed shaft in the feed mechanism. Trip-pins on the worm-wheel control both the idle movement and the working feeds.

The first and second tool positions are at the front, and the threading and accelerating spindles at the rear, this arrangement providing maximum convenience in setting up box-tools. The third position in the tool turret is fitted with a revolving die-spindle; this spindle is driven from the center shaft by gears at *M* which give two selective threading speeds of 1 to 3 and 1 to 4 ratio. A clutch actuated by cams provides an increased speed in backing out a tap or in running off a solid die. The feed and return movements of the tool are controlled by cams on drum *N*. A neutral position is provided for the driving clutch when there is no threading to be done, and in such cases the die-spindle is clamped in the turret, so that any tool can be used in this position.

A feature of the tool turret is the provision of an independent spindle in the fourth position. By means of this arrangement, any operation can be performed and completed by the tool in this position before the other tools have finished their work. The feed of this independent spindle may be accelerated to more than twice that of the turret or it may be reduced to less. Thus the tool in this spindle can be used for reaming or finish-turning the total length of work covered by the first- and second-position tools, and the tool will recede from the work before the other tools have reached the end of their cutting strokes. With this provision the operation of the cut-off tool is not delayed. The action of this independent tool is also controlled by a cam on drum *N*. Shaft *O* is connected to the rear of the independent tool-spindle, and is operated from the cam by means of a lever. When this action is not required, the stop-collar may be disconnected and the spindle clamped to the turret, as mentioned previously.

Three cross-slides are provided as regular equipment for rough- and finish-forming operations, and there is a fourth slide which may be used as a special attachment. The spindle cylinder is provided with individual cross-slide stops for use on each spindle. The cross-slides are operated by levers *P* which are readily accessible for adjustment. Each slide has its individual cam, and can be moved into any position relative to the work. The camshaft is also readily accessible for setting the different cams, and is out of the way of chips and cutting oil. A safety pin is provided in the worm-wheel at *Q*, which will shear off in case of interference or overload on any of the cams, and stop the tool turret and all cross-slides before damage can be done.

The tool turret *R* is of the familiar Cleveland type, consisting of a cast-iron cylinder mounted in a bearing and sliding on a steel center tube *T*. This tube is hardened and ground and supported in a fixed bearing in back of the turret and in the spindle cylinder at the opposite end. This type of turret affords a solid tool support against strain resulting from the simultaneous operation of several tools. The construction has been worked out to insure permanent

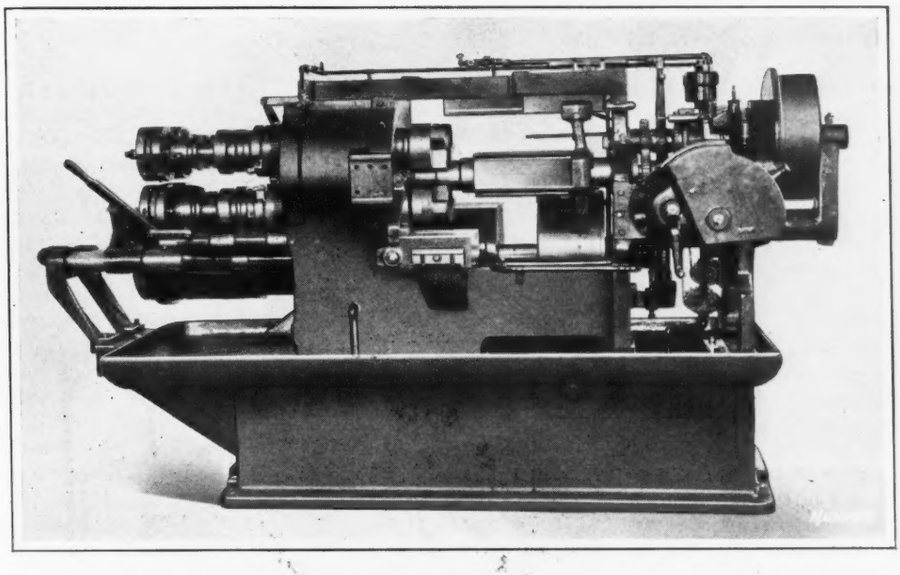


Fig. 1. Gridley Four-spindle Chucking Machine equipped with either Air or Mechanically Operated Automatic Chucks

alignment. The ⅞-inch machine has a capacity for handling round stock up to ⅞ inch in diameter, hexagonal stock up to ¾ inch, and square stock up to ⅝ inch. The floor space occupied is 36 by 96 inches, and the weight of the machine, including a countershaft, is about 4700 pounds.

GRIDLEY MULTIPLE-SPINDLE CHUCKING MACHINE

A new model H four-spindle Gridley chucking machine for handling forgings and castings has recently been brought out by the National Acme Co., Cleveland, Ohio. This machine is furnished with automatic chucks which may be actuated either pneumatically or mechanically. The design of the machine follows that of the Gridley multiple-spindle bar machine in so far as the different type of work permits, and so a detailed description of the mechanisms common to both machines will not be necessary. The turret arrangement and the Geneva stop revolving mechanism of the former machine are used. The Geneva mechanism indexes the carrier with an intermittently accelerated and retarded motion, which practically obviates strain or shock in indexing or locking.

The chucking mechanism is built around the air chuck heretofore used with the single-spindle automatics built by this company for chucking work. The chucks generally provided are of the sliding three-jaw type with the jaws actuated by gear teeth on the short arms of pivoted levers whose long arms are connected in the same way to the end of a draw-bar passing through the spindle. Mounted on the rear of each spindle is an air cylinder in which the piston is actuated to move the draw-bar back and forth. Behind the air cylinder is a four-arm spider casting which is fastened to the spindle carrier and revolves with it. At the center of this spider is a swivel connection to which an air-supply hose is coupled, and from this connection radial ducts pass through the four arms of the spider to the valve chambers.

The valves themselves are revolving disks which admit air into the front of the cylinder to close the chuck and into the rear to open it. These rotary valves are actuated by plunger racks which slide parallel with the spindle and mesh with pinions on the valve stems. The plungers are normally pushed to the rear by coil springs, and while in this position, maintain an air pressure in the front of the cylinders to keep the chucks closed.

One at a time the spindles stop automatically for loading, while the other three continue to run. The stopping occurs when the spindle comes into the lower rear or fourth position. The mechanism for this purpose consists of a gear that is free on the spindle and is provided with a cone clutch seat in a large hub at the rear. Keyed to the spindle and fitted into this cone clutch seat is a bronze clutch ring, and behind this ring is a special finger-holder in which are pivoted three operating fingers. The front ends of the fingers bear against the chamfered rear face of the clutch ring, while the rear ends work in conjunction with a clutch-operating spool. As the clutch-operating spool is pushed forward, it spreads the fingers and these in turn react upon the clutch ring, seating it into the spindle gear and thus driving the spindle. When the clutch is withdrawn, the fingers collapse and a set of spring plungers within the spindle gear unseat the clutch ring and disconnect the gear from the spindle As the spool is withdrawn, its rear face bears against spring pins in the back of the air cylinders which act as brakes to bring the spindle to an immediate standstill.

A cam on the drum at the rear of the machine, as shown in Fig. 2, comes into play when any spindle reaches the fourth position, moving back a slide which, in turn, withdraws the clutch-operating spool. As soon as the spindle stops, another cam on the same drum moves a similar slide forward, which pushes down the plunger of the valve mechanism and releases the work, leaving it free to fall out or be removed by hand. The spindle then remains stationary with the clutch open for a sufficient length of time to allow

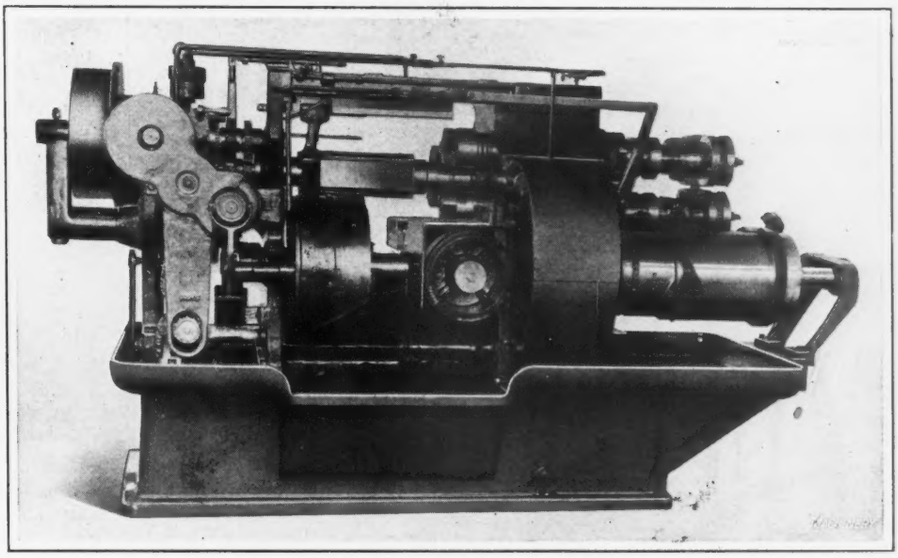


Fig. 2. Rear View of the Gridley Chucking Machine

a new piece to be loaded into the chuck, after which the cams continue their action, releasing the valve plungers and closing the chuck jaws firmly on the work.

When this has occurred, the other set of cams moves the clutch spool forward to start the spindle, and then the machine indexes. The operator stands at the rear of this machine, and so the lever for engaging the feed is extended so that it may be operated from either the front or the rear. The air chucks can also be operated manually in any position by applying a wrench on the square end of the valve stems, which makes it possible to remove work for examination at any stage of machining.

In the mechanically operated machine, the air cylinders are replaced by a special finger-holder and a cushioned reaction plate which is actuated by a second spool similar to that used in conjunction with the clutch. The finger-holder is mounted on the draw-bar of the chuck behind the end of the spindle, and the reaction plate is screwed to the end of the spindle. The reaction plate consists of two parts, separated by a number of stiff springs, and in the operation of the chucks it takes the place of the elasticity afforded by the air in the pneumatic chucks, and thus insures firm chucking without crushing the work or straining the mechanism. The draw-bar is constantly pressed toward the spindle nose by a heavy coil spring in the rear end of the spindle, and tends to open the chuck when the fingers collapse. However, a positive opening is insured by a slide similar to that which opens the air chucks, this slide being actuated by a cam on the drum at the rear. Adjustment of the chuck jaws through their entire range is provided for by nuts on the rear end of the draw-bar behind the finger-holder. Both illustrations show the machine equipped with mechanically operated chucks. This machine will swing chucks up to 6½ inches outside diameter, and has a rated chucking capacity of 4½ inches. In special cases, a tool-slide feed of 5 inches is available.

MAX AMS AUTOMATIC BLANKING AND EDGING PRESS

An automatic No. 403 blanking and edging press which combines in one machine two usual operations in the production of body sections for tubs, pails, and similar articles, constitutes the latest development of the Max Ams Machine Co., 101 Park Ave., New York City. With other equipment the machine is capable of performing similar operations on other classes of work. Only one operator is required, and he merely places the metal sheet on the feed table against a back gage, the action being completely automatic from this point on. Sheets up to 72 by 27 inches can be handled, and in the case of the press shown, a sheet of this size furnishes six blanks. Not only does the machine effect a saving in labor, but it also relieves the operator of the hazard of feeding work directly into the die.

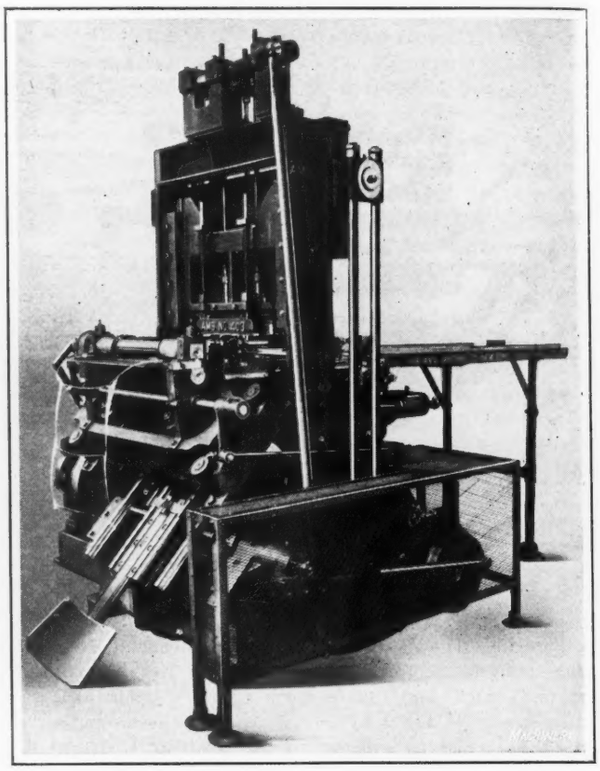


Fig. 2. Rear View showing the Discharge of the Work and Scrap

The machine consists of an upright blanking press and a 45-degree inclined forming press, both of which receive their reciprocating motion from the same shaft. Twin gears with attached eccentrics drive the blanking press crosshead, while the forming press slide is actuated by a pitman and cranks inside the housings. The machine is double back-geared, and equipped with a friction clutch controlled by two hand-levers. It can be arranged for either a belt or direct motor drive.

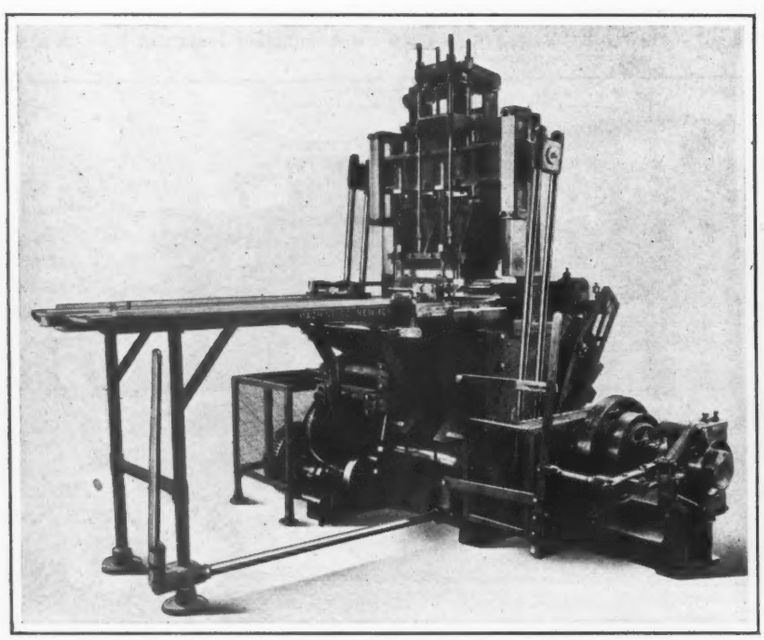


Fig. 1. Max Ams Automatic Combination Blanking and Edging Press

From the feed table the sheet is automatically brought forward into the path of the gripper feed, which, in the case of the press illustrated, occurs at every sixth stroke. The grippers deliver the sheet to the blanking die, spacing it accurately. When the last blank has been cut, the scrap is ejected from the rear of the machine by means of rollers, as shown in Fig. 2. The blank is pushed through the blanking die onto an inclining device which holds it by means of suction cups and swings it into a 45-degree position in alignment with the top of the forming die. A reciprocating feed slide at right angles to the forming press then takes the blank from the inclining device and delivers it to the forming die.

A vacuum pump for the suction cups of the inclining device is connected directly to the machine. Stock can be cut within close limits; there may be a narrow margin of only ⅛ inch along the edges of the scrap. The machine has an output of about 35 blanks per minute and weighs approximately 17,000 pounds.

DAVIS ROTO-MATIC PIPE THREADING MACHINE

An automatic machine for threading electric conduit has just been developed by the Davis & Thompson Co., Milwaukee, Wis., and is being marketed by William K. Stamets, Jenkins Arcade Bldg., Pittsburg, Pa. The machine is made in two sizes, the No. 2 threading pipe from ½ to 2 inches in nominal diameter, and the No. 3 machine, from 1½- to 4-inch pipe. The double-end machine illustrated is adapted to the standard conduit length of 10 feet; for random lengths, a battery of two single-end machines is needed. In general principle, this pipe threading machine is similar to other Davis machines of the rotating type. The six-station work-spindle rotates in synchronism with two six-spindle tool drums, one at each end of the machine.

A hopper or feeding chute is supplied for convenient loading, and the finished work drops on inclined ways at the rear and rolls into position to be taken away. The coolant which drips from the ends of the conduits and from the die-heads returns to two pumps at the rear through a series of screens and baffles, and is then circulated again.

Special self-opening die-heads are mounted on the cutter-spindles of the two drums. Each die-head slides with its spindle and is backed up by coil springs so that inequalities up to 1 inch in the length of work can be compensated for. As may be seen from Fig. 2, each die-head is brought up to the work by means of a follower roller actuated by a stationary cam. The die-head is bell-mouthed so that slightly bent conduit can be drawn into it and centered. The two-jaw work-holding chucks are allowed to float slightly so as to permit bent work to be aligned. Each die-head pulls itself on the work, cuts the thread to a predetermined length, and is then tripped and returned to the starting position. A tool within the die-head chamfers the inside of the work. The chucks are closed by toggles operated from a short shaft which is given the necessary motion through a clamping arm located beneath the clamping chain. This chain travels with the work-spindle without a relative motion between the chain and clamps. The desired tension on the chain is secured by means of the idler sheave.

An unusual arrangement is employed to bring coolant to the die-heads. Surrounding the face of the spindle drum adjacent to the work is an annular casting which is U-shaped in cross-section. The U-legs join the drum and are packed at the joint so that a water-tight chamber is formed around the drum for the coolant. The main feed pipe is tapped into this chamber and beside each spindle is a coolant pipe which is tapped into the face of the drum and connected to the coolant chamber by a passage. The flow of coolant is cut off when the dies are not working. It is stated that in threading ½-inch conduit, an output of 2400 pieces per hour has been obtained.

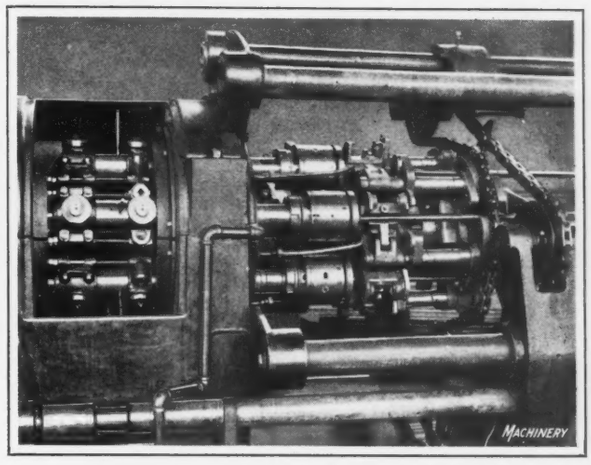


Fig. 2. Close-up View of the Clamping and Tooling Arrangements

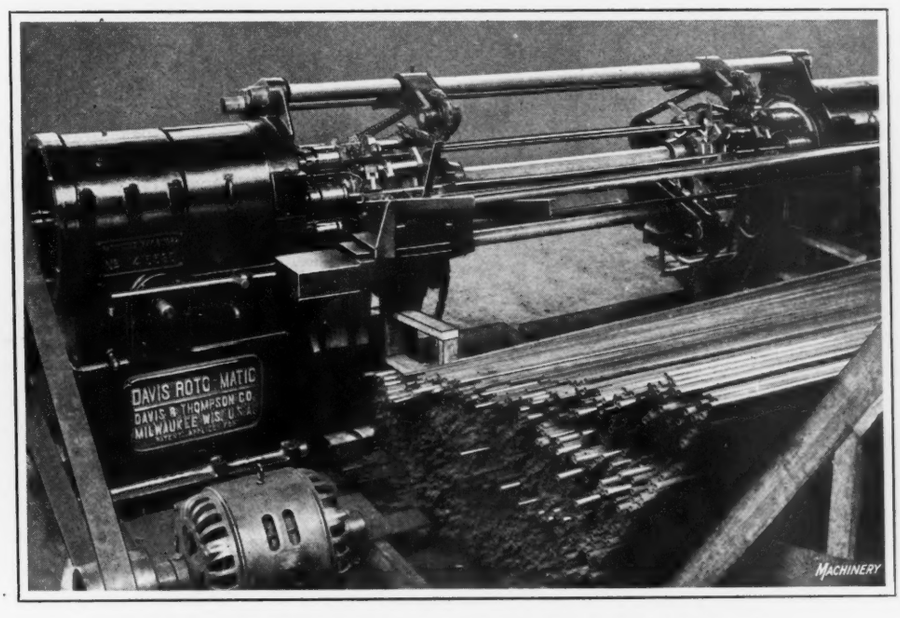


Fig. 1. Davis "Roto-matic" for threading Both Ends of Pipe simultaneously

H & G DOUBLE-SPINDLE THREADING MACHINE

A double-spindle threading machine is now built by the Eastern Machine Screw Corporation, 23-43 Barclay St., New Haven, Conn., which consists of two single-spindle H & G machines mounted on one pedestal. The single-spindle machine was described in June, 1921, MACHINERY. This arrangement is said to be economical wherever the time of threading is longer than the time of chucking. The machine may be equipped with the spindle-and-collet type of tailstock when short pieces are to be handled, or with a tailstock of the quick-acting open-side jaw type when the work consists of long pieces such as rods.

NILES-BEMENT-POND LATHE

A new line of lathes built in sizes of 27, 30, and 36 inches swing has recently been developed by the Niles-Bement-Pond Co., 111 Broadway, New York City. With a view to obtaining strength and rigidity, the bed is cast with a solid web near the top which joins the two ways, and there are double-wall cross-ties every two feet. Large LeBlond-type compensating vees are also provided for the carriage; the tool-slide is of heavy design with a wide bridge; the apron is cast in one piece with double walls; positive fine-tooth clutches are supplied in the apron for the longitudinal and cross feeds; heat-treated steel Maag gears are furnished throughout; all gear shafts have at least two bearings, including the motor drive shafts; and the tailstock is of the four-bolt type with a double-plug spindle clamp.

Ease of operation has been increased by the application of a rapid power traverse for the carriage which is regularly furnished; a quick-change gear-box for the feeds; direct-reading plates for selecting desired feeds and speeds; a thread dial

which makes is unnecessary to reverse the motor in thread cutting; and provision for starting and stopping the machine from the carriage. On machines driven by a variable-speed direct-current motor, full advantage is taken of the motor by making the speed changes also from the carriage. There is a "jog" push-button on the head for driving the motor slowly while shifting gears.

The solid web of the bed referred to is inclined so that chips falling on the web will slide to the rear, where there are holes in the bed wall so that they can fall into a pan from which they may be conveniently removed. The LeBlond type of bed vee is said to reduce the bearing pressure per unit of area and thus lessen the amount of wear. The carriage is furnished with two sets of track wipers to prevent scoring the ways, and oil is delivered to the working surfaces between these wipers, so that the latter help to keep it on the surfaces instead of wiping it off.

Fig. 2 gives an idea of the compact design of the carriage and apron which enables the operator to get close to the work without stooping. In this illustration the operator is shown manipulating the power rapid-traverse lever with his left hand while he is adjusting the tool-slide with his right hand. The handwheel on the apron is used for making small adjustments of the carriage. The upper tool-slide is offset so that the ball-crank cannot interfere with the wrench on the carriage screw. Longitudinal and cross-feeds are obtained by operating the same lever, but it is impossible to obtain one feed coincidentally with the other.

The power rapid-traverse screw is provided with right- and left-hand threads, and is mounted along the rear of the bed, being driven by a separate motor through a gear-box. Right- and left-hand nuts ordinarily rotate on this screw, but when the lever at the front of the carriage is moved, one or the other of the nuts is held stationary, the particular nut depending upon the direction in which the operator wishes to move the carriage. The fine-tooth clutches of the apron previously mentioned permit of snapping the feed in and out instantly, which is especially advantageous when turning to a shoulder. Interlocks prevent the operator from engaging the lead-screw nut when the power feed is being used. The machine is equipped with a taper attachment. Careful attention has been given to lubrication, filtered oil being pumped to all gears and bearings in the head, and the feed gear unit being connected to the oil supply for the head so that all gears and bearings in this unit are also constantly flooded.

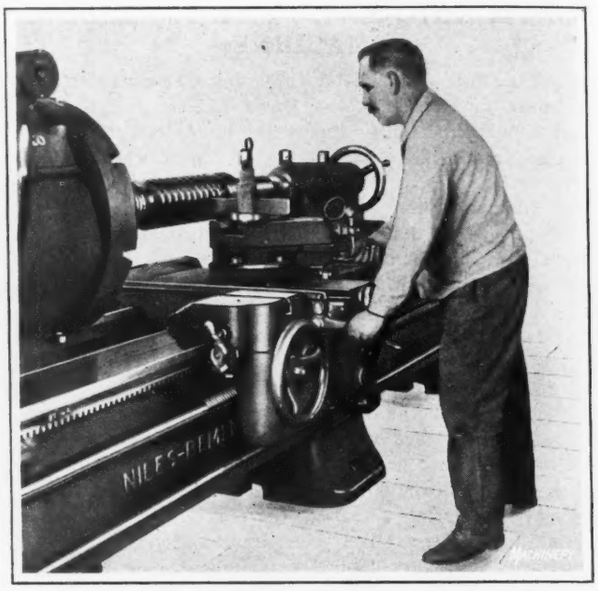


Fig. 2. View in which the Operator is manipulating the Power Rapid-Traverse Lever and the Tool-slide Handle

None of the driving gears are overhung, and they are enclosed in a housing which is flooded with oil. The first driving pinion shaft has a bearing on each side to relieve the motor armature shaft of the load induced by the belt and gears. Alternating- and direct-current motor drives and a single-pulley belt drive may be provided. A pump for delivering cutting compound to the work is driven from the rapid-traverse gear-box, the coolant being delivered from a tank in the leg at the head end of the machine.

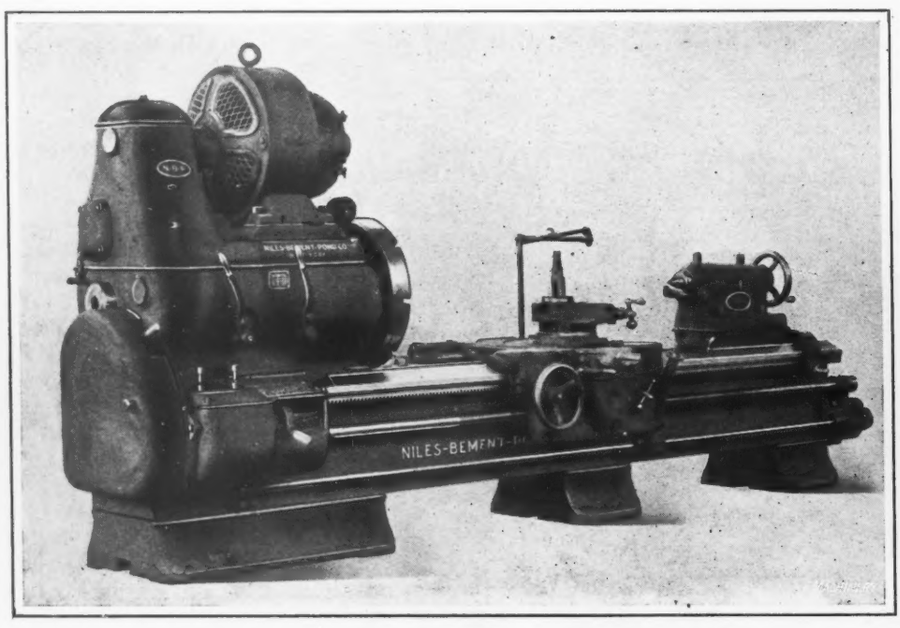
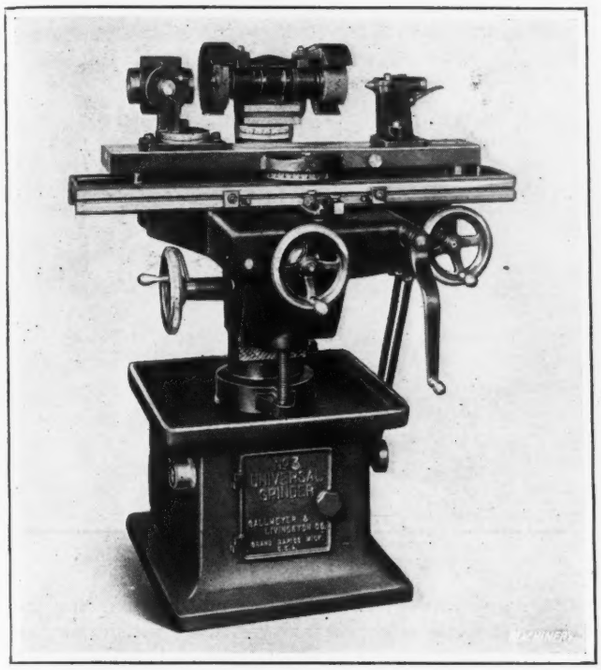


Fig. 1. Niles-Bement-Pond Lathe which embodies Many Improved Features

GRAND RAPIDS UNIVERSAL CUTTER AND TOOL GRINDER

A machine recently brought out by the Gallmeyer & Livingston Co., 344 Straight Ave., S.W., Grand Rapids, Mich., known as the No. 4 Grand Rapids universal cutter and tool grinder, embodies a number of features new to this type of machine. The drive to the wheel-head is so arranged that the head can be swiveled 180 degrees without any belt interference. As shown in the illustration, the wheel-head carries a wheel at each end, and in addition, arrangement is made for mounting an internal grinding attachment on the wheel-head. In all cases, except when the internal grinding attachment is in use, the two wheels on the head can always be held in position for instant use. In addition to the swiveling of the wheel-head, the whole upper part of the machine can be swiveled a full 360 degrees to place the wheels and work in the best position for the operator and to enable light to be obtained from the right side. Operating handles and handwheels are so placed that the machine can be operated from either the front or back.

The table also swivels so that it may be set to any angle required for grinding tapered work. This setting can be done



Grand Rapids Universal Cutter and Tool Grinder

very accurately by the use of micrometer adjusting screws, which are independent of any support on the sub-table, so that the adjustment may be obtained in whatever position the table occupies. Four changes of table power feeds in the longitudinal direction are provided, varying from 8 to 52 inches per minute. The machine may also be furnished without this power feed. The gears in the gear-box for the table power feed run in a bath of oil.

The headstock is provided with an independent motor, giving two changes of speed and permitting the use of a dead center for cylindrical work. The change from a revolving to a dead center is easily made. The motor headstock swivels, for convenience when grinding faceplate work.

The machine can be furnished either belt-driven from an overhead drum countershaft or motor-driven with the motor placed in the base and all overhead works eliminated, as shown in the illustration. It can also be furnished either with or without a wet grinding attachment which consists of a pump, tank and piping.

The size of the table is 5½ by 42 inches; the longitudinal travel, 24 inches; the transverse movement, 9 inches; and the vertical movement, 10¾ inches. The maximum distance from the center of the spindle to the table is 10½ inches, and the maximum length of work, 32 inches. Face milling cutters up to 18 inches in diameter can be handled. The net weight of the machine with standard equipment is 1550 pounds.

FEDERAL DIAL INDICATOR

A model 50 dial indicator has just been placed on the market by the Federal Products Corporation, 15 Elbow St., Providence, R. I. This indicator is identical in size and general appearance with the model D brought out some time ago by this company. However, a complete turn of the hand equals a movement of 0.030 inch, whereas on the model D indicator, it equals 0.040 inch. Consequently, the new indicator is graduated 0-15-0, or plus and minus 15, the model D indicator being graduated 0-20-0. The indicator dial is further subdivided to 0.0005 inch.

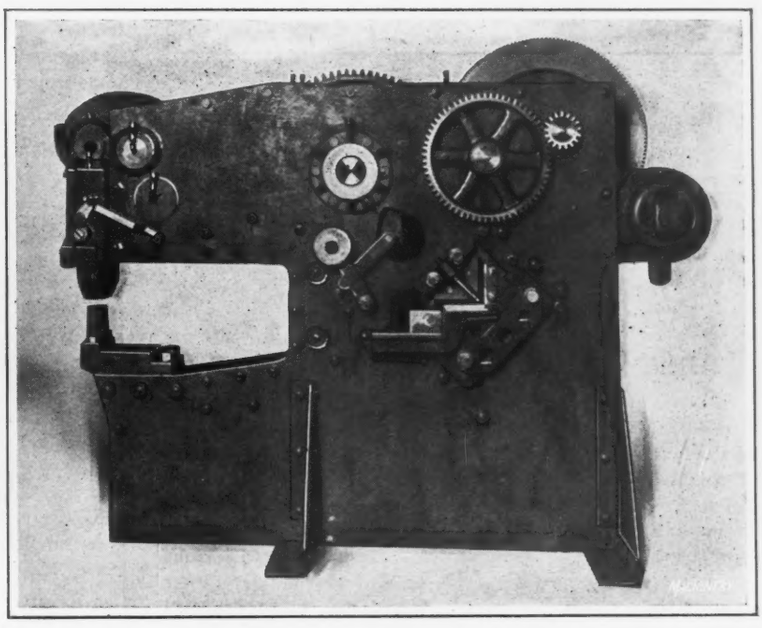
In order to completely disassemble the indicator, only a few steps are necessary as follows: Unscrew the cap at the top; remove two screws on the back, and lift the back off; remove two large screws which hold the entire movement within the case; slip off the spring from the pin in the rack and unscrew the pin with the fingers; withdraw the rack completely; and lift out the movement. To reassemble the indicator, the order of the foregoing steps is reversed. The movement consists of the Federal top and bottom plate construction similar to the design of a watch, which insures alignment of all gears. The bezel clamp is also of the patented design previously used which permits of rotating the dial to any desired position and locking it there.

BUFFALO IMPROVED PUNCH AND BAR CUTTERS

The single-end punch and bar cutters built by the Buffalo Forge Co., 144 Mortimer St., Buffalo, N. Y., are now provided with an improved method of engaging the plunger which insures a more positive action. The new method consists of a block and ram controlled by a counterweighted lever. The block remains stationary, while the ram, which actuates the plunger, moves in a semicircular direction and seats on the tool-steel block. The counterweight on the controlling lever automatically throws the plunger into either an engaged or a disengaged position.

A gag is provided which can be engaged either by hand or foot to operate the punch, and there is a second gag for use in setting up dies and punches and locating center marks. By pulling out this gag and pushing in the main gag, the punch will descend without penetrating the material. Wear is taken up in the plunger by means of a bronze taper wedge. The machines can also be furnished with plate shearing tools that are interchangeable with the punch. However, in such a case, an extension must be provided at the base of the larger machines.

The bar cutters will cut round, flat, and square stock, and angle- and T-irons. Angle-irons can be mitered up to 45 degrees. The frame is built of steel having a tensile strength of approximately 60,000 pounds per square inch, the plates being bolted together in such a way that springing of the frame is impossible.

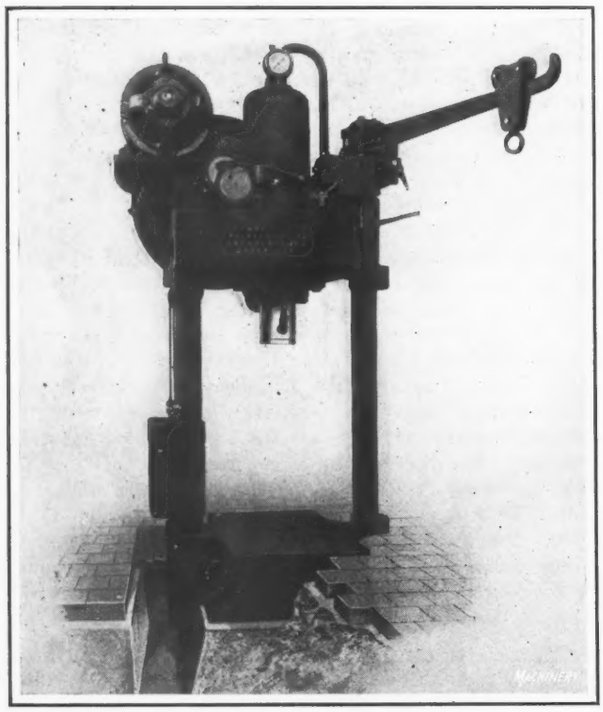


Buffalo Improved Single-end Punch and Bar Cutter

CHAMBERSBURG HYDRAULIC FORCING AND BENDING PRESSES

A line of model B hydraulic forcing and bending presses, designed to meet the requirements of railroad, automobile, and general machine shops, has recently been developed by the Chambersburg Engineering Co., Chambersburg, Pa. These presses are built in four sizes of 50, 75, 100, and 125 tons capacity, respectively. They may be used for such work as forcing mandrels and bushings, broaching, pressing gears into place, and inserting and removing locomotive driving-boxes and brasses.

A feature of the presses is the hydro-pneumatic action by means of which the ram is brought down to the work by air pressure, the actual work being accomplished hydraulically at any pressure within the capacity of the machine. A large weighted "pull-back" assures a fast return of the ram. The motor, pump, and crane are installed on the top platen, so as to give free access to the press from all sides, and the top platen also serves as a reservoir for the water. The controlling valves are so placed on one side of the machine

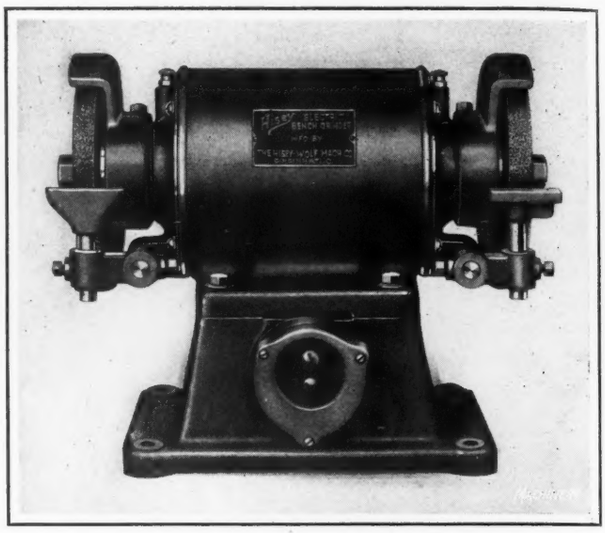


Chambersburg Press with Hydro-pneumatic Action

as to give the operator an unrestricted view of the work and the gages. The stroke ranges from 13 inches on the smallest size to 24 inches on the largest. A 5-horsepower motor drives the two smaller sizes and a 7½-horsepower motor, the two larger sizes. In each case the motor speed is about 1000 revolutions per minute. The standard crane on all sizes has a lifting capacity of 1000 pounds.

HISEY ELECTRIC BENCH GRINDER

A two-wheel 6-inch motor-driven bench grinder recommended for very light grinding has recently been designed by the Hisey-Wolf Machine Co., Cincinnati, Ohio. A feature of this equipment is a thermostatic safety motor switch which provides the advantages of a fuse by controlling the circuit and thus protecting the motor. The motor is of ¼ horsepower capacity and runs at a speed of 3400 revolutions per minute under no load. It may be furnished for either alternating or direct current. Wheel guards of the full safety combination type may be provided. Guards of this type are adjustable to any angle, and can be moved back as the grinding wheel wears away so as to give full access



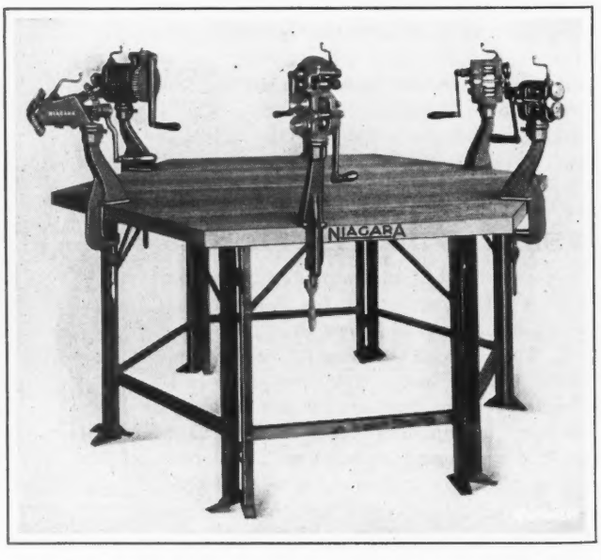
Hisey Bench Grinder for Very Light Grinding

to the wheel, as well as to provide maximum guard protection. The full safety guards are fitted with removable end covers and exhaust pipe connections, and they are interchangeable with the standard wheel-end guard illustrated. The weight of this bench grinder is about 70 pounds.

NIAGARA "HEXO" BENCH

A bench that is designed for use in sheet-metal shops and is particularly adapted for use in school shops, has recently been brought out by the Niagara Machine & Tool Works, 637-697 Northland Ave., Buffalo, N. Y. This "Hexo" bench has six sides so as to combine maximum working space with minimum floor space. The hexagonal construction was adopted because of the fact that there are primarily six bench machines in the average sheet-metal shop, namely, burring, turning, wiring, setting down, crimping, and beading machines. These machines are regularly furnished with standard holders which can be used on the bench, so that any machine equipped with a standard holder can be moved to some other bench for temporary use.

The bench measures 5 feet across flats, which is large enough to give sufficient room to permit six operators to work at the bench at one time without interfering with one another. There is also room at the center of the table for laying down work. The bench is supported by six built-up angle-iron legs which are tied together by braces. The top

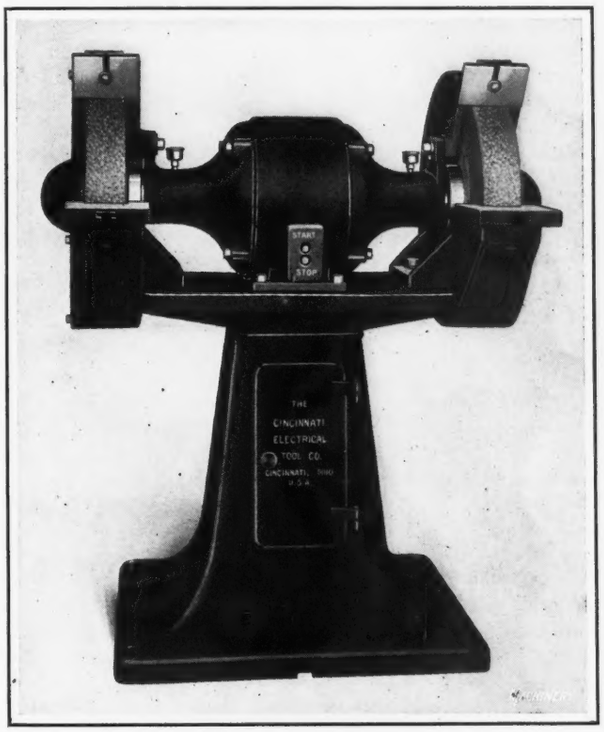


Niagara Bench for Sheet-metal Shops and Vocational Schools

is made of 2-inch dressed maple boards. An additional lower shelf can be placed on the angle-iron bracing near the bottom of the legs. The bench weighs about 250 pounds.

CINCINNATI FLOOR GRINDER

A five-horsepower heavy-duty floor grinder intended for heavy grinding of all kinds in railroad shops, foundries, structural iron plants, etc., has been added to the line of equipment built by the Cincinnati Electrical Tool Co., 1501 Freeman Ave., Cincinnati, Ohio. The motor is furnished with ball bearings, and is fully enclosed to prevent emery dust and dirt from getting into the bearings and windings. This grinder will carry wheels up to 18 inches in diameter and 3 inches face width. The wheel guards are of the exhaust type, to comply with safety standards, and they are adjustable to compensate for wear of the wheels. Removable covers bolted to the guards completely enclose the sides of the wheels and the flanges and nuts. The starting switch is of the magnetic type with a push-button control, and it

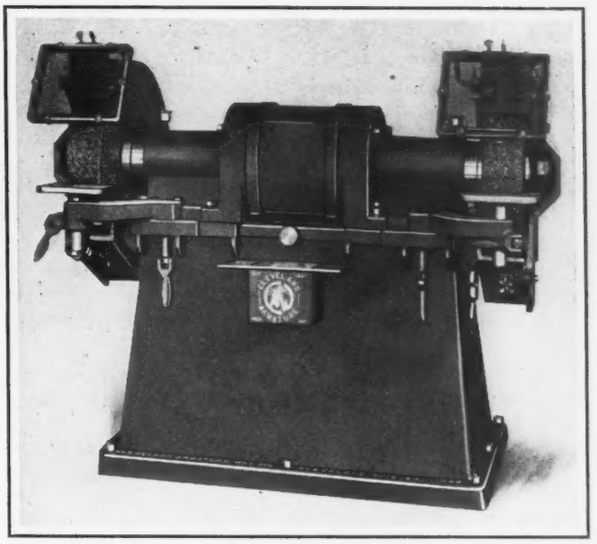


Cincinnati Five-horsepower Floor Grinder

is mounted on a separate panel within the column. This grinder is built to be driven by 220- and 440-volt, 25- to 60-cycle, two- or three-phase alternating current.

CLEVELAND MOTOR-DRIVEN FLOOR GRINDER

A heavy-duty motor-driven floor grinder recently developed by the Cleveland Armature Works, Inc., 4732 St. Clair Ave., Cleveland, Ohio, is shown in the accompanying illustration. This machine is built in two sizes equipped with 10- and 15-horsepower motors, respectively. The base is made of steel and cast-iron parts, electrically welded together, and it is filled with concrete to absorb vibration. The motor windings are insulated and treated with an oilproof compound. A large fan located at each end of the motor promotes cooling, and the stator laminations are exposed to the air to reduce heating in overloads. The motor shaft operates in taper roller bearings which can be adjusted to compensate for wear. These bearings are pressed into steel containers.

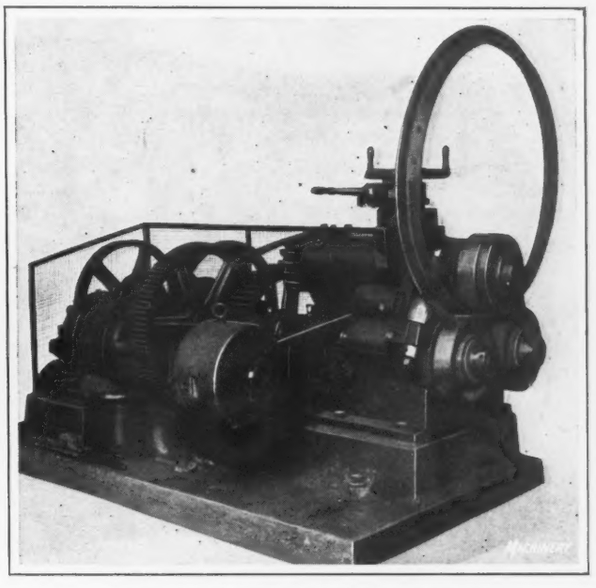


Cleveland Motor-driven Floor Grinder

Safety features were given careful consideration in the design of this grinder, as will be noticed by the fact that the wheels are provided with heavy wire-glass eye shields, mounted in metal frames. These guards protect the operator's eyes effectively. A steel plate is mounted at the front of each wheel at the upper guard opening to deflect sparks and pieces of wheel fragments in case of a wheel fracture. The wheel guards are heavy steel castings which may be adjusted to compensate for wear of the wheel. A positive shaft lock holds the spindle firmly when changing wheels, thus eliminating danger of crushing the operator's fingers. The electric control operates in oil so that no live parts are exposed. Starting and stopping of the grinder are accomplished by operating a knob which is within easy reach of the operator. The weight of the 10-horsepower machine complete with 18- by 3-inch grinding wheels is about 3450 pounds, and the weight of the 15-horsepower size equipped with 20- by 4-inch wheels is about 3675 pounds.

BUFFALO BENDING ROLLS

Several improvements have been made in the Nos. ½, 1, and 2 bending rolls built by the Buffalo Forge Co., 144 Mortimer St., Buffalo, N. Y. The principal feature of the new design is that the rolls are adapted for bending angle-



Bending Rolls built by the Buffalo Forge Co.

irons singly with the leg toward either the inside or the outside. With the older design it was possible to bend angle-irons with the leg inside only, by placing the angle-irons in pairs with the backs bolted together, and using flat rolls. Easier and more even adjustment of the rolls in bending is assured through the substitution of a counterbalanced lever for the springs which formerly supported the top roll and bearing. Less pressure is needed to regulate the rolls, and at the same time the wear on the controlling mechanism is reduced.

A new spacer arrangement on all three rolls insures easy adjustment of the space provided to take care of the thickness of the leg on angle- and T-irons. By this arrangement binding of the leg is prevented, regardless of the size. The same rolls are also used for narrow, flat bars. Two inclined guide rolls on each side overcome any tendency of the iron to bend sideways; however, these guide rolls must be removed when bending T-irons.

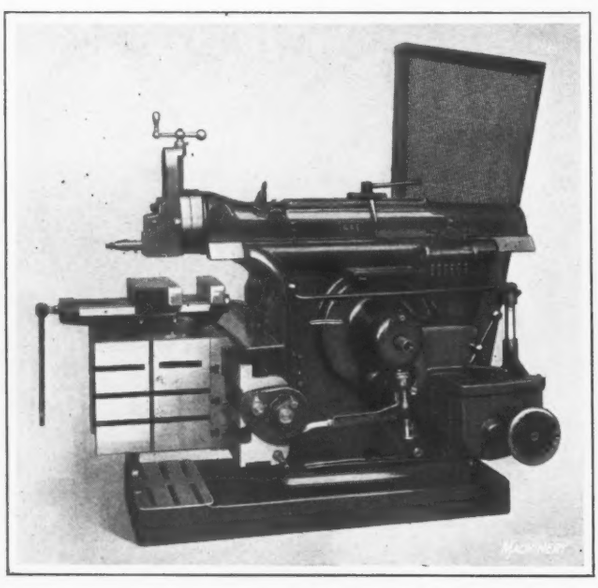
The smallest machine is not reversible, but the other two are equipped with reversing clutch pulleys which make it possible to pass work through the rolls in either direction. In addition to the work mentioned, the machines are adapted to bending channel irons, I-beams, rails, wrought-iron pipe, and odd sections. Rolls can also be furnished for bending annealed copper tubing without filling the tubes with resin. It is mentioned that in one shop the No. 2 machine bent 3- by 3- by ⅜-inch angle-iron rings to a diameter of 42 inches at the rate of 24 rings per hour.

GOULD & EBERHARDT SHAPERS

A number of new features and improvements have been incorporated in the entire line of shapers built by Gould & Eberhardt, Chancellor Ave., Newark, N. J., though the basic design and general lines of the machines remain the same as before. A multiple gravity oiling system is now provided to automatically lubricate all main internal bearings. This system is used because the shafts do not run at very high speeds and therefore require only a moderate amount of oil. The operator may turn the lubricant on or off as required, which depends upon how hard the shaper is being run. This oiling system also eliminates a number of moving parts.

The lever for shifting the gears in the speed gear-case has been moved from the bottom to a more convenient location on top of the case. There is also an index-plate, so arranged that the operator can readily determine just how many strokes the machine is making per minute. The starting and stopping lever has been made longer, for the convenience of the operator, and another improvement is a simple lock for the tool-head slide.

The handle for clamping the ram adjusting nut is now a drop-forging, and the movable vise jaw has a solid top which is accurately machined to provide more space for using surface pointers in squaring up work. The guard over the cross-rail is made of sheet metal so as not to break, and there is provision for preventing chips from getting under the guard and in back of the slide. Means are provided for oiling the cross-slide, and oil wipers keep all cross-rail bearings clean.

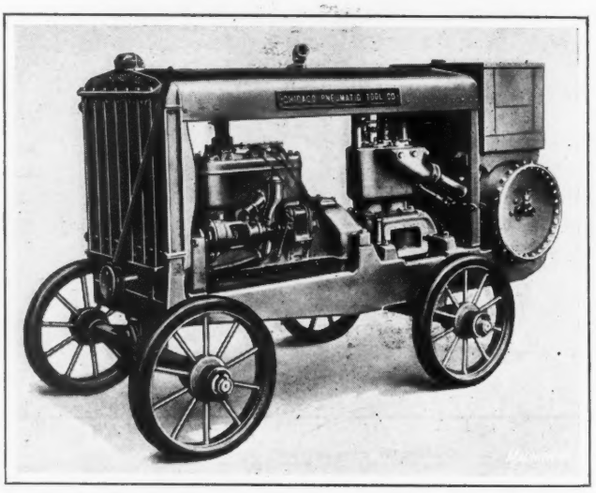


Gould & Eberhardt Shaper embodying a Number of Improved Features

CHICAGO PNEUMATIC PORTABLE AIR COMPRESSOR

A gasoline-engine-driven portable air compressor having a capacity of 100 cubic feet is now built by the Chicago Pneumatic Tool Co., 6 E. 44th St., New York City. The compressor is of the vertical single-acting duplex type equipped with Simplate inlet and discharge valves. A differential unloader regulates the air supply, and an auto-pneumatic throttle provides additional fuel economy by slowing the engine to idling speed during the unloaded periods and speeding it up again just before the load is resumed. Splash lubrication is used, and a small pump driven by gears from the crankshaft maintains a constant oil level in the connecting-rod splash troughs and supplies oil to the main bearings. Glass inserts in the removable doors of the crankcase permit convenient inspection of the lubrication system.

A flexible coupling connects the compressor directly to a heavy-duty four-cylinder gasoline engine. When desired, this coupling can be quickly disconnected for starting. Both the engine and compressor are cooled by a large radiator, which is built in sections and protected against damage by vertical bars. A cast-steel deck serves as a common base for the engine, compressor, and air receiver. The gasoline tank is carried in a separate section of the tool-box which may be locked. The unit may be supplied with several different mountings including a one-ton Ford truck chassis.



Chicago Pneumatic Portable Gasoline-engine-driven Air Compressor

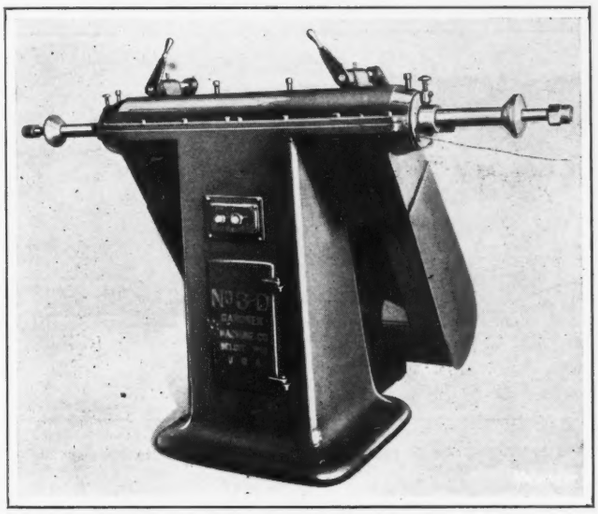
GARDNER DOUBLE-SPINDLE POLISHING MACHINE

A No. 3-D motor-driven double-spindle polishing machine is being introduced to the trade by the Gardner Machine Co., 414 E. Gardner St., Beloit, Wis. The method of driving this machine provides for running the two spindles at speeds different from that of the motor shaft and of each other. Thus one spindle may be used for polishing while buffing is being performed with the other. The different speeds are obtained by the use of different diameter pulleys in the

drive. The wheel-spindles are entirely separate, and each one carries tight and loose pulleys.

The motor shaft is extended at each end so that pulleys can be mounted on it, and these pulleys are connected by belt to those on the machine spindles. A belt-shifter is furnished for throwing either driving belt into the neutral position, and thus stopping one of the spindles without interfering with the other. The motor is mounted on a sliding baseplate which provides for taking up the stretch of belts. A motor of five-horsepower capacity, running at a speed of from 1700 to 1800 revolutions per minute, is recommended. The motor is started and stopped from a push-button control station located on the front of the pedestal, the starting mechanism being mounted inside the base, so that the machine is entirely self-contained.

The machine is also built in a belt-driven style which may be driven from a point overhead or in back of the machine.

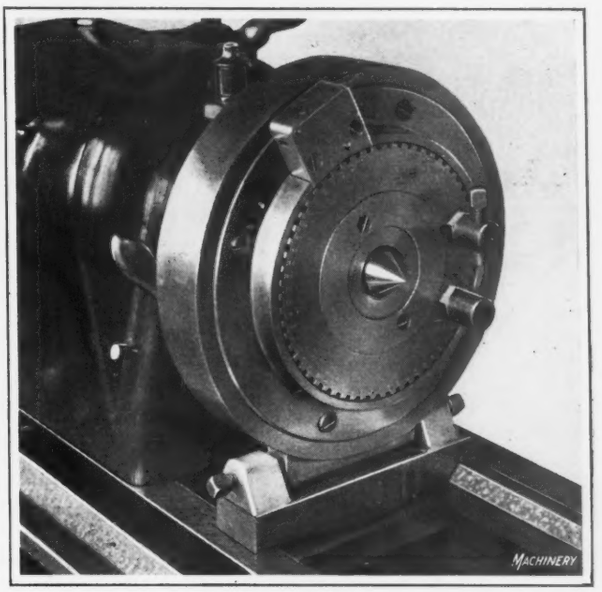


Gardner Double-spindle Polishing Machine built in Motor- and Belt-driven Types

In this case, the two spindles may be run at different speeds by simply equipping the lineshaft with pulleys of different diameters. In each machine the spindles are mounted in ball bearings which are enclosed in dustproof housings. Complete disassembly of either end of the machine is possible without interfering with the operation of the other end. The spindle housings are provided with a lubrication chamber that is large enough to keep the bearings submerged in oil at all times. Hardened steel safety nuts are furnished, and the motor-driven machine is equipped with a spindle-locking device which may be employed to lock a spindle when it is desired to change the wheel.

PRATT & WHITNEY SPEED-REDUCING FACEPLATE

A speed-reducing faceplate applicable to the 16-inch model B lathe built by the Pratt & Whitney Co., Hartford, Conn., has recently been designed by this company. The faceplate gives a 6 to 1 reduction to whatever spindle speed is engaged, making speeds as low as two revolutions per minute available. For driving the device, there is a gear attached to the spindle nose and two planetary gears mesh with this gear and with a large internal gear which is held from rotating by being clamped to the bed. The planetary gears drive at the reduced speed a separate plate which carries a driving dog. The regular headstock center mounted in the spindle nose is used for this attachment; thus the original accuracy of the headstock is insured, because there is no extra mechanism between the lathe spindle and the work center. The attachment is easy to operate, and can be set up or removed about as quickly as an ordinary face-plate.



Pratt & Whitney Speed-reducing Faceplate

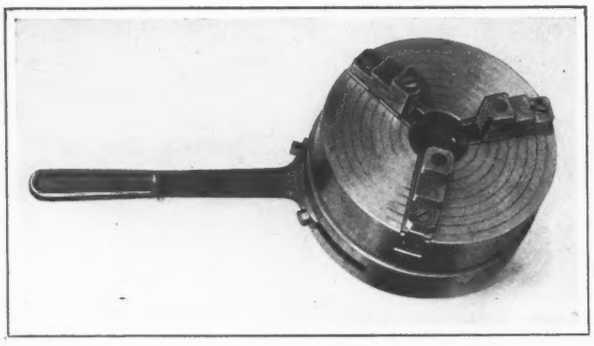
The attachment was primarily developed for use in relieving operations, this type of work requiring a slow spindle rotation. The relieving attachment for the lathe has been so designed, in conjunction with this speed-reducing faceplate, that no additional relieving tables are necessary. Two different speed drives are provided for the relieving attachment, one for use with the faceplate, and the other for relieving without it. The slow rotation of the spindle also makes possible very accurate thread chasing, and it is useful in taking long-lead cuts. Cuts having a lead up to 12 inches per revolution have been taken with a feed of 0.002 inch without obtaining chatter marks.

The faceplate is also designed to be used for accurate indexing, a plate with sixty notches giving every subdivision needed in ordinary work. A pawl engages the notches as desired, and each notch is numbered so that there is no difficulty in obtaining correct indexing. The indexing feature is particularly valuable in connection with long-lead operations where there are usually a multiple number of starts. If desired, the gearing may be locked to eliminate the speed reduction, in which case the attachment serves as a regular indexing faceplate.

WRENCHLESS QUICK-ACTING CHUCK

An improved type of wrenchless quick-acting chuck has recently been placed on the market by the Thomas Elevator Co., 24 S. Hoyne Ave., Chicago, Ill., to supplement the Barker wrenchless chuck originated and built by this concern. This new chuck was designed with a view to eliminating difficulties experienced by users of chucks of this type. The device consists of a base chuck, which is nothing more than the essential mechanism for a simple external chuck, including only the first or actuating jaws. To this base chuck can be added any desired combination of jaws and cam. The chucks are furnished in external or internal types or in a combination of the two. It is possible for one or two of the jaws to remain stationary while all the clamping is done by the other jaws; this feature is especially valuable in handling accurate work. Different types of jaws can be furnished, one arrangement being a combination called the "manufacturing with solid master jaws" chuck. With this combination are obtained all the advantages of the solid manufacturing chuck and in addition it is possible to use standard slip-work jaws such as are used on other types of quick-acting chucks.

In a test conducted with a 16-inch chuck of the new design, it was possible for an operator to release with the left

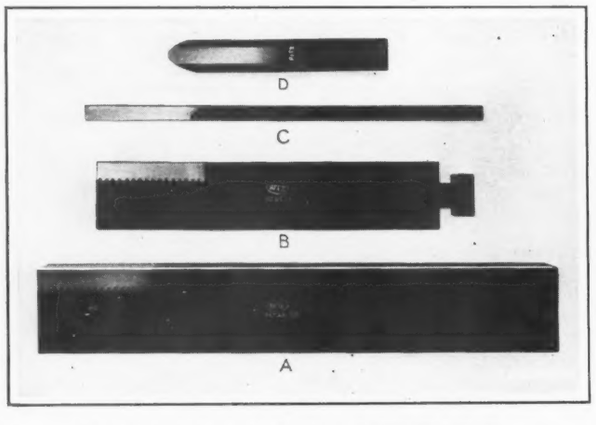


Wrenchless Quick-acting Chuck made by the Thomas Elevator Co.

hand a 10-inch steel forging which had been chucked tight enough to take a cut ½ inch deep at a feed of 0.030 inch. The time necessary to chuck and release this forging amounted to less than fifteen seconds. One of the advantages of this chuck in the multiple production of pieces of uniform outline is that it is not necessary to stop its rotation for chucking or ejecting work. The chuck is equipped with the Alemite lubrication system and requires little attention after it has once been filled with grease.

RITZ-TIP TOOLS

Tools with a non-ferrous metal alloy cutting tip cast on a carbon steel shank, are being introduced on the market by the Ritz Tool Mfg. Co., Inc., 189 Ridge St., Newark, N. J. Several examples of these tools are shown in the accompanying illustration. This alloy, which is known as "Ritz-Metal," is non-magnetic and cannot be forged, machined, tempered, or annealed. It is claimed to be especially tough, have a fine and dense structure, give a long life between grinds,



Tools with Carbon-steel Shanks and "Ritz-Metal" Tips

and be rustproof. It is said to have tensile and shearing strength equal to high-speed steel.

Each tool shank is so milled at the front end as to produce a series of serrations and then these are hammered under a power press to give a slight dovetail effect between each ridge. After thoroughly cleaning the serrations, the Ritz-Metal is cast on them through the use of a mold. The alloy is securely locked in place by the dovetails, and in addition the contraction of the alloy in cooling causes the ridges at the two ends to bend in opposite directions and further anchor the alloy in place. The tip and shank are then ground smooth, and the shank given a rustproof finish. It is stated that the alloy tip will continue to cut in an operation even though it reaches a white heat.

Tool bits of this construction are made in all standard sizes from ¼ to ¾ inch to be ground at the front end by the customer. At *A* in the illustration is shown a large tool, 1 inch wide; at *B*, a special ¾-inch tool intended for use on a "Lo-swing" lathe; at *C*, a cutting-off tool 7/32 inch wide; and at *D* a special threading tool that must be ground to the desired thread form. On the last tool mentioned, the Ritz-Metal is held in place by one large dovetail slot which runs longitudinally in the shank. Other types of tools with the alloy tip, including inserted blades for milling cutters, are also made.

LE BLOND RAPID-TRAVERSE LATHE

The 17-inch heavy-duty geared-head lathe built by the R. K. Le Blond Machine Tool Co., Cincinnati, Ohio, which was described in February MACHINERY is now equipped with a rapid-traverse mechanism. This mechanism entirely eliminates the necessity of moving the carriage by hand, and as the movements are made quickly, it has a direct bearing toward increased production. The mechanism consists principally of a housing bolted and doweled to the back of the carriage, and a coarse-pitch right- and left-hand

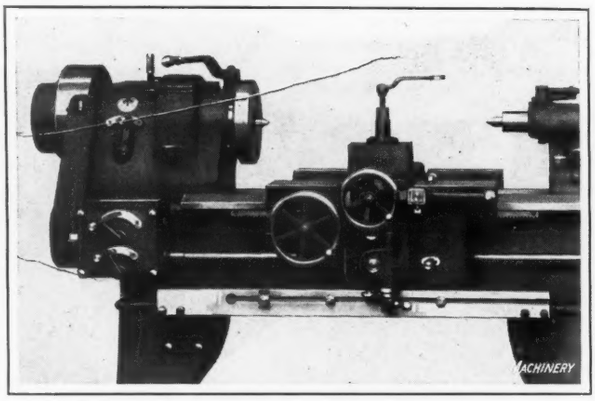


Fig. 1. LeBlond Rapid-traverse Lathe equipped with Spacing Bar

traverse screw, as shown in Fig. 2. Both the feed and traverse are controlled by a single operating lever, the movement of which in the horizontal plane, engages or disengages the feed. When the lever is moved in the vertical plane, it engages the traverse. A slight pressure on the operating lever is sufficient to keep the traverse engaged, and when the pressure is released the carriage stops instantly. There are two directions of traverse and there is a neutral position to which the lever automatically returns as soon as pressure on it is released. The feeds and traverse are interlocked, so that it is impossible to engage the two at the same time.

When the operating lever is moved in the vertical plane, motion is transmitted through a shaft and clutch finger to a positive sliding double clutch. This clutch engages similar clutches on two nuts on the screw, one of which engages the left-hand thread and the other the right-hand. The traverse screw is revolved at a constant speed, as it is driven direct from the driving pulley by belt and through differential reduction gearing. The rate of traverse is uni-

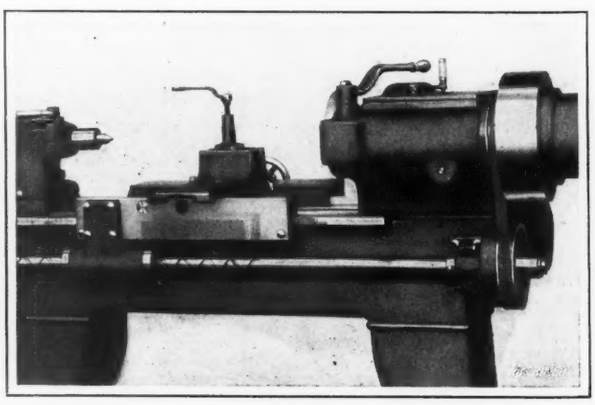
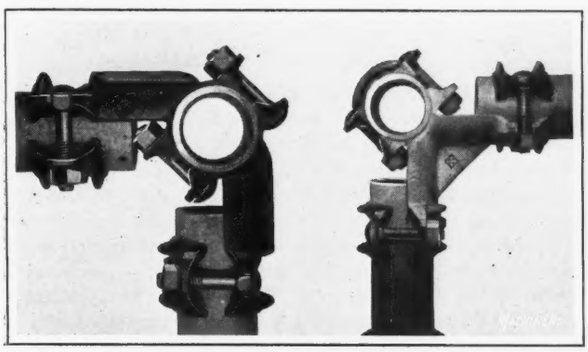


Fig. 2. Rapid-traverse Mechanism on the LeBlond Lathe

formly 150 inches per minute. A positive traverse stop is provided at the tailstock which, in conjunction with the automatic stop in the apron for the feed, provides automatic stops in both directions. The spacing bar illustrated in Fig. 1 can be furnished to combine positive adjustable length stops for both the feed and traverse.

WESTINGHOUSE PIPE FITTINGS

A line of fittings primarily designed for use with wrought-iron or steel pipe in the erection of electrical switching equipment, has been placed on the market by the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Another use for the fittings is in the construction of racks, railings, and bench or table frames. The fittings are malleable-iron castings having a minimum tensile strength of 50,000 pounds per square inch, and they are made in a relatively few styles that permit a large variety of combinations. At the left, in the accompanying illustration, are shown two four-way or side-outlet tees. The fittings are designed for two standard pipe sizes, 1¼ and 2 inches, and for a combination of these sizes; however, there are a few styles of ¾-, 1-, and 1½-inch sizes.

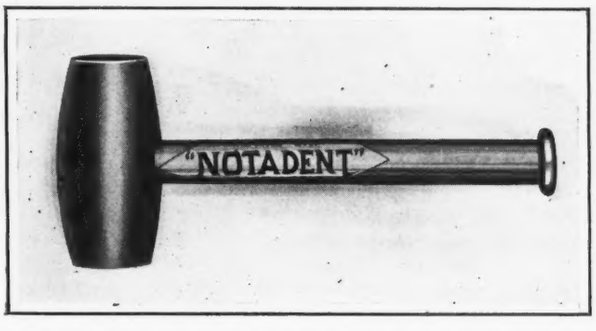


Westinghouse Pipe Fittings for Use in installing Electrical Equipment, Benches, etc.

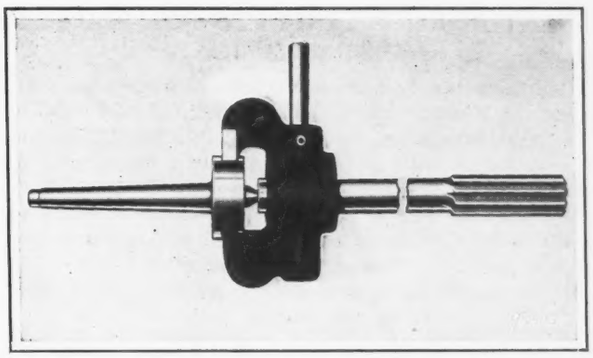
The principal feature of the fittings is a ribbed yoke which is clamped over the pipe by heavy carriage bolts to the other unit part. Some parts, as shown, have two or more yokes cast in a single piece with connecting webs. The only tools necessary in erecting a structure with the fittings are a pipe vise, pipe cutter, and an open-end or socket wrench for each of the two sizes of bolts.

"NOTADENT" SOFT-METAL HAMMER

A soft-metal hammer is manufactured by the New England Sales & Engineering Co., Worcester, Mass., in six sizes, ranging in weight from 2¼ to 8 pounds. Of the six sizes, three are made of babbitt metal and the remaining three of bronze, so that the mechanic may choose a hammer best suited to his particular work. The metals are blended with a view to obtaining hammers that will withstand rough usage with the least amount of wear.



Soft-metal Hammer made by the New England Sales & Engineering Co.

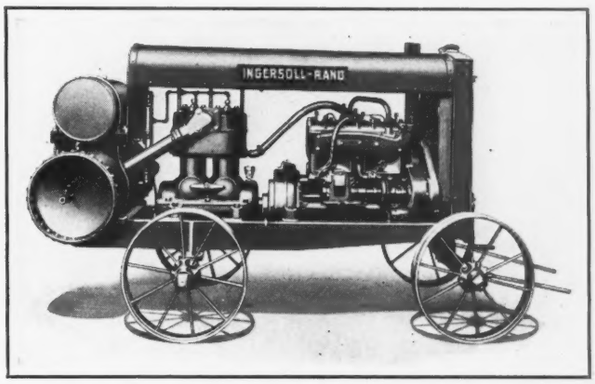


Nicholson Drill and Reamer Holder for Use in Various Machine Tools

NICHOLSON DRILL AND REAMER HOLDER

A device for holding drills and reamers in various machines constitutes a recent development of W. H. Nicholson & Co., 112 Oregon St., Wilkes-Barre, Pa. When used in the tailstock of a lathe the holder is said to prevent the production of taper holes, because it lines up the tool and holds it in position. Slipping a drill off the center is also prevented, and there is no side pressure on the tool, such as is caused by a dog or wrench. The tool may be changed quickly without making adjustments. In a lathe the device can also be used as a driver or "hold-back." It can be used in a turret lathe or screw machine as a floating holder.

Another use of the holder is in drilling machines, where it can replace the regular chuck. Here the hardened steel plates line up the drill and the center holds it in alignment. The holder is furnished with either a taper or a straight shank up to 1½ inches in diameter. It is made in two sizes for holding reamers with straight shanks up to 1 and 2 inches in diameter, respectively.



Ingersoll-Rand Small-sized Portable Air Compressor

INGERSOLL-RAND AIR COMPRESSOR

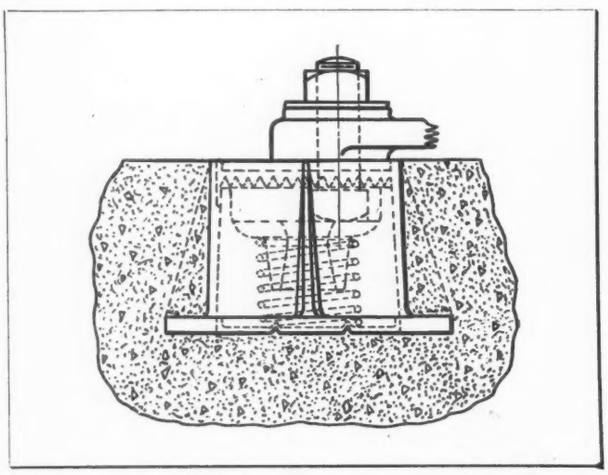
A small portable air compressor recently developed by the Ingersoll-Rand Co., 11 Broadway, New York City, is shown in the accompanying illustration. This compressor is designated as the 4¼- by 4-inch type Twenty, and has a piston displacement of 60 cubic feet per minute. It is built along the same lines as the larger type Twenty outfit, retaining all the features of the larger machine. The vertical compressor is direct-connected to a four-cylinder, four-cycle, tractor-type gasoline engine. There is a circulating water cooling system for the engine and compressor, with a sectionalized radiator, fan, and pump, and there is a compressor regulator and engine control for reducing the speed during the unloaded periods. The equipment is mounted on a one-piece cast-steel frame, and covered by a sheet-steel roof. The side doors are removable, as shown, to make all parts of the outfit readily accessible. The compressor can be furnished with various types of mountings, including a Ford truck.

WESTINGHOUSE INSERTS FOR MACHINE INSTALLATIONS

For fastening machinery to concrete floors, walls, or ceilings, the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has brought out the adjustable bolt insert here illustrated. When bolts are embedded directly in concrete, considerable care is necessary in positioning the bolts, or else they will not register with the holes on the machine and must be forced into position, with perhaps mutilation of the threads, or the bolt holes must be reamed to suit. This insert obviates these disadvantages, because it permits adjustment of the bolt after the concrete has set.

The insert consists of a cast-iron tapered housing which contains a rotatable bolt carrier. This carrier is T-slotted to receive the head of a standard machine bolt, and permits a ⅝-inch movement of the bolt radially from the center. The position of the bolt can be adjusted in any direction by simply rotating the carrier. The housing and carrier are provided with teeth which mesh and prevent any change in position after the adjustment has been made and before the bolt has been tightened. These teeth are kept in mesh by a retaining spring.

In installing the insert, the form for the concrete is drilled at the point where the bolt is to be placed, and the

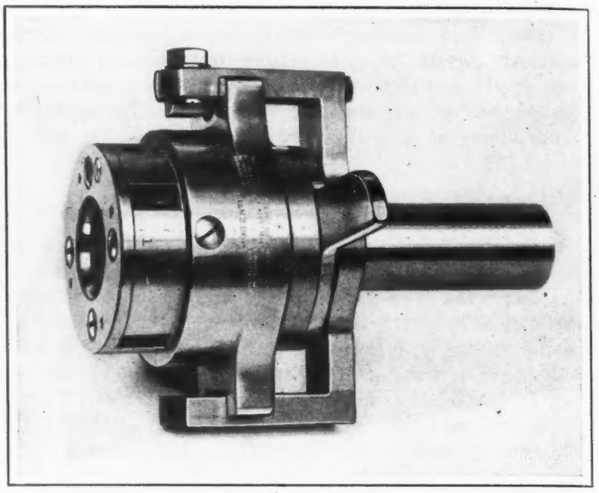


Westinghouse Bolt Insert for attaching Machines to Concrete

insert is then fastened to the form by a bolt which extends through the form and screws into a nut in the T-slot of the carrier. After the concrete has set, this preliminary bolt and nut are removed and a bolt of the proper length to suit the machine is placed in the bolt carrier. These inserts are available for ⅜- and ½-inch machine bolts.

"TAPEROD" WELDING ELECTRODE

A tapered electrode designed to be gripped in the electrode holder by its larger end so that the smaller end can be used in starting the arc, has been brought out by the Electric Arc Cutting & Welding Co., 152 Jelliff Ave., Newark, N. J. It is known by the trade name of "Taperod." As the heat increases during the process of welding, the constant and uniform increase in the thickness of the electrode is said to provide heat compensation along the entire length, so that welding may proceed uniformly without changing to a heavier rod as the heat increases. The gradually increasing diameter of the rod also allows a corresponding increase in deposition with a constant heat value in the deposit. The heating of the rod due to resistance loss is said to be compensated for by the larger diameter of that part of the electrode which carries the current the longest. Waste ends are reduced to a minimum, because the electrode does not get red hot as it becomes short. Welding can be started in narrow corners.



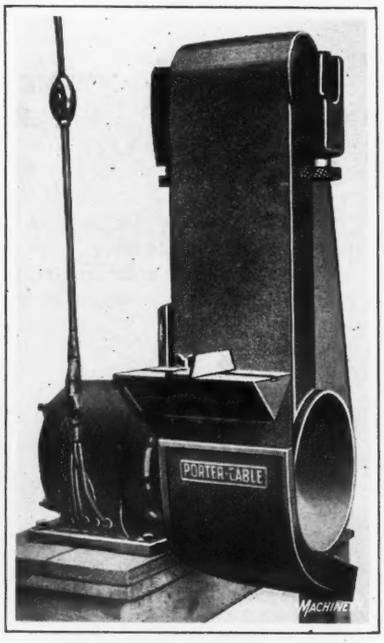
Improved H & G Die-head for B & S Automatic Screw Machines

H & G DIE-HEAD

A new development in the H & G die-head made for Brown & Sharpe automatic screw machines by the Eastern Machine Screw Corporation, 23-43 Barclay St., New Haven, Conn., has just been placed on the market. The new die is similar to that shown in February MACHINERY except that two arms extend from the floating shank instead of one, the two arms providing a double drive that is said to reduce friction to a minimum and prevent any tendency of the die-head to cramp while threading. The new die-head is available in a 9/16-inch size for the No. 2 machine; a 7/16-inch size for the No. 0 machine; and a 1/4-inch size for the No. 00 machine. As the die-head is equipped with a handle for closing by hand, it is suitable for use on hand turret machines for fine thread work, where a sensitive trip and the ability of the die-head to follow its own lead without distorting the thread is desirable.

PORTER-CABLE BELT SANDER AND GRINDER

A belt sander and grinder with a bed 6 by 18 inches has been brought out by the Porter-Cable Machine Co., 1708-12 N. Salina St., Syracuse, N. Y., to meet the demand for a belt surfacing machine of a smaller size than that which has been built by this company for about two years. This machine may be used vertically, as shown, or in a horizontal position, thus being adapted for many operations. It is driven by a ½-horsepower motor which is direct-connected to a 7½-inch driving pulley, this drive supplying ample power for all work within the capacity of the machine. The adjusting screws are along the side of the frame where they



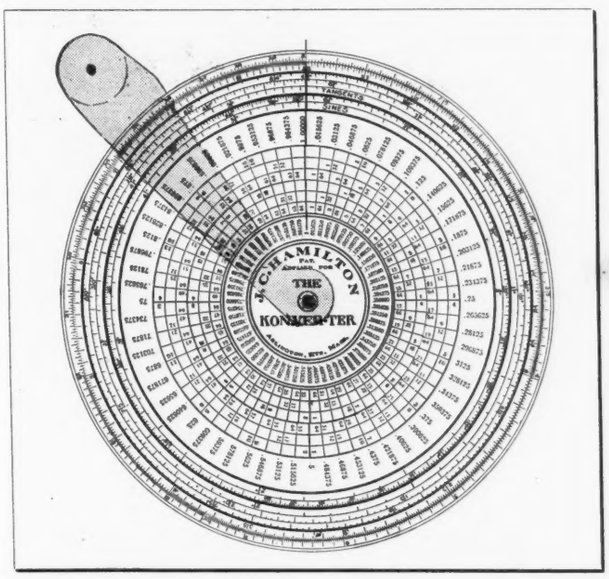
Porter-Cable Horizontal or Vertical Belt Sander and Grinder

are not in the way when belts are being changed. Different kinds of belts may be used to allow operations to be performed on wood, metal, horn, bone, or composite materials. For work requiring a finished curved surface the upper pulley may be a semicircular spindle.

The table is removable to accommodate work requiring the full grinding bed, or it may be employed as a stop when the equipment is used in the horizontal position. The dust hood may also be taken off in a few seconds. This machine may be mounted on a bench or it can be furnished on a portable pedestal for use when the work is scattered about the plant. Current for the motor may be taken from any lamp socket. The motor speed is 1725 revolutions per minute, and the belt speed, 3300 feet per minute. The table tilts 45 degrees down and 15 degrees up.

"KON-VER-TER" SLIDE-RULE

A circular slide-rule designed to facilitate calculations in engineering departments has recently been placed on the market by J. C. Hamilton, 7 Water St., Boston, Mass., under the trade name of "Kon-Ver-Ter." This device has scales on both sides and may be used for multiplying; dividing;

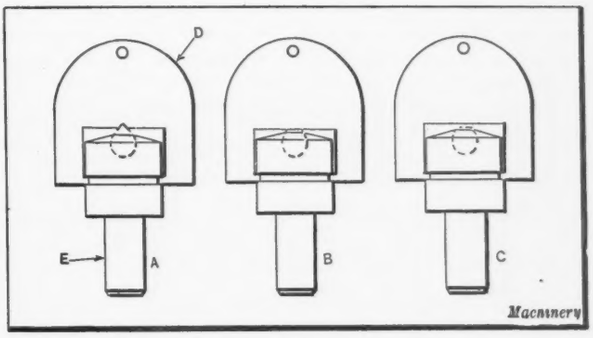


"Kon-Ver-Ter" Slide-rule for Engineering Calculations

adding and subtracting fractions; determining the trigonometric functions of angles; finding logarithms, anti-logarithms and co-logarithms; and calculating the square, cube, and fifth roots or powers of numbers. The slide-rule consists of three celluloid disks and a celluloid arm. The largest disk measures 5¾ inches in diameter.

"DYKON" DIAMOND GAGE

The common practice in the use of diamonds for truing grinding wheels is to depend upon the judgment of the operator and his foreman as to the length of time that a diamond should be used. With such a method, it often occurs that a particularly hard diamond finds favor with the operator and he will keep it in service too long, consequently imperilling the life of the diamond. Figures can be presented to show how the life of a diamond may be prolonged by scientific use. In grinding crankshafts, a comparative record was kept of the average service rendered by diamonds of the same size and quality. Diamonds accorded careful use and timely resettings had an average life of 48 weeks; diamonds used in the ordinary manner and with delayed resettings, 40 weeks; and diamonds used carelessly and with disregard to resetting, only 28 weeks.



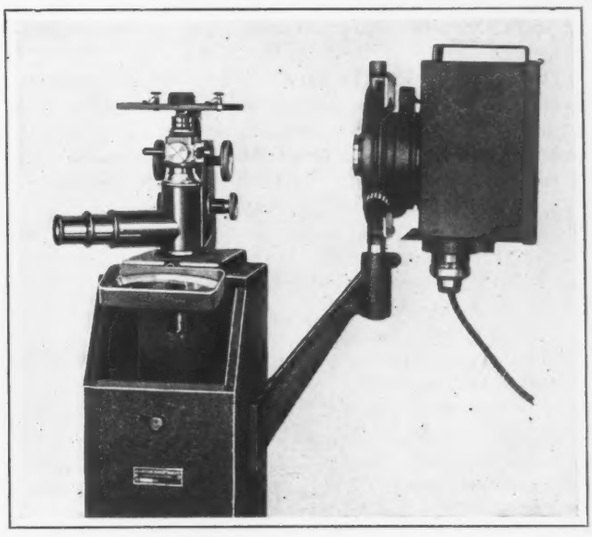
Diagrams indicating the Method of using the "Dykon" Diamond Gage

To promote a more scientific use of diamonds, the Joyce-Koebel Diamond Co., Inc., 39 W. 32nd St., New York City, has brought out the "Dykon" gage D, which is intended for use in conjunction with a grooved diamond tool *E*. The gage has two projections which register with the groove in the holder, and when a new diamond is being tested, it should be impossible to pass the gage over the point, as illustrated at *A*. When the diamond has been so worn that the gage can be passed over the point, as shown at *B*, it has been worn to the safety point and should be reset. However, when the diamond is as shown at *C*, it has been worn below the safety point and its life is imperilled. Thus the gage makes it possible to determine readily when to stop using a diamond.

It is common knowledge that the hard outer surface of a diamond gives the longest life, and by resetting the stone according to the gage, it is possible to use the maximum amount of outer surface. A diamond that has been worn beyond the depth of the gage to a very flat surface requires greater pressure in dressing the wheel, with the result that a large amount of heat is generated, and the diamond is likely to break and disintegrate. The gage is standard, but the groove is varied according to the size and shape of the diamond. The gage can be used without removing the holder from the machine. Each time the diamond is reset, an entirely new holder should be used and grooved.

BAUSCH & LOMB METALLOGRAPHIC EQUIPMENT

A simplified metallographic equipment for general routine inspection is being introduced to the trade by the Bausch & Lomb Optical Co., Rochester, N. Y. Such inspection seldom requires magnifications above 200 diameters, and hence the apparatus does not contain the expensive parts necessary



Bausch & Lomb Metallographic Equipment for Routine Inspection

in research outfits. As all parts are mounted on one base and the light source is in a fixed position, the equipment comprises a compact unit. It includes an inverted microscope, camera, and special ribbon filament illuminant. It is portable, easy to operate, and gives magnifications varying from 64 to 210 diameters.

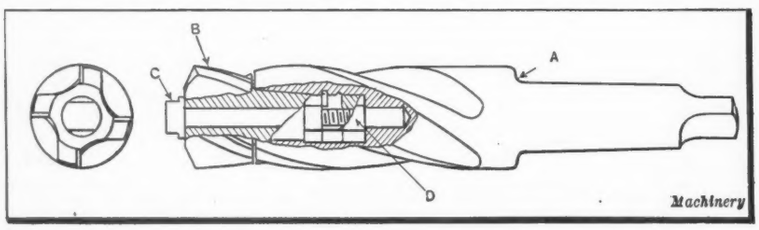
GENERAL ELECTRIC MAGNETIC MACHINE TOOL CONTROLLERS

A new line of magnetic machine tool controllers has been placed on the market by the General Electric Co., Schenectady, N. Y., which employs the counter-electromotive force method of acceleration. These controllers are applicable to both reversing and non-reversing, constant- and adjustable-speed drives requiring normal starting conditions. They have been developed primarily for application to direct-current motors in sizes ranging up to and including 15 horsepower.

The controller provides two accelerating points; the starting resistor is automatically short-circuited in one step upon proper acceleration of the motor. This is accomplished by an accelerating contactor, the closing of which is governed by the counter-electromotive force of the motor. Coincident with the adoption of the new type of starter for the smaller motors made by this company, the larger types of magnetic machine tool and general-purpose controllers have been completely redesigned.

GAIRING CORE DRILL

A core drill, known as type C, which is intended for boring out or enlarging cored holes in steel, iron, and malleable-iron castings, has recently been developed by the Gairing Tool Co., Inc., Detroit, Mich. This tool consists essentially of a holder *A* and a cutter *B*. The cutter has a taper shank which seats in a corresponding hole in the holder, the cutter being attached to the holder by means of a draw-bolt *C*. The internal end of this bolt is screwed into a floating hexagonal nut *D* which is seated in the holder



Gairing Core Drill with Interchangeable Cutter

in such a way that it cannot turn. The nut is retained by a spring.

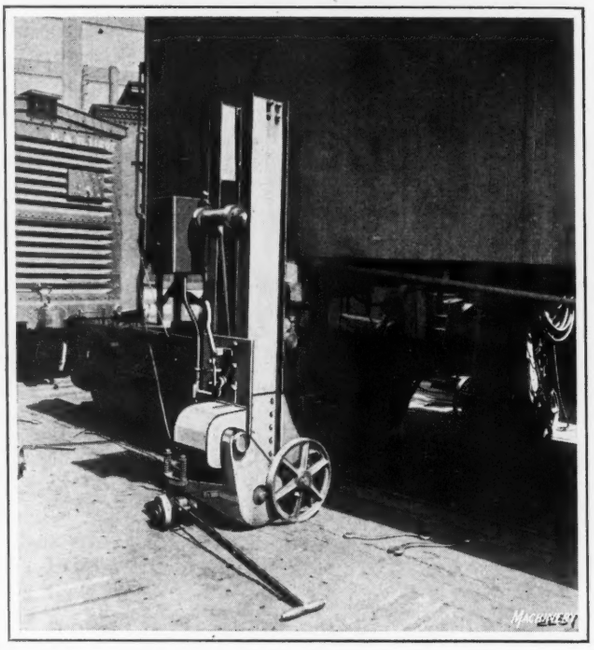
The shank end of the cutter is also made hexagonal to prevent it from rotating relative to the holder. Bolt *C* may be provided with a large finished head to serve as a pilot when the tool is used in counterboring operations. There is a hole drilled through the holder at right angles to its axis through which a drift pin may be inserted for removing the cutter. The tapered shank construction is said to result in the cutter being fastened concentrically and rigidly to the holder. This core drill is made in a number of sizes.

* * *

The Panama Canal is becoming of ever-increasing importance in the world's commerce. The figures for the tonnage passing through the canal are rapidly approaching those of the Suez Canal. The greatest number of commercial sea-going vessels that have passed through the Gatun Locks separately in one day is 24. Actually, 38 vessels have been passed through in twenty-four hours, but these included submarines and destroyers passing through the locks in groups.

HOIST FOR RAILWAY CARS

In repairing railway coaches and freight cars, it is often desirable to raise the car proper from one or both trucks. A portable hoist designed for accomplishing this easily is built by the Whiting Corporation, Harvey, Ill. The application of this hoist is shown in the accompanying illustration. The portability of the unit makes it unnecessary to provide a special foundation or pit for repair work of this sort, and



Portable Hoist which facilitates the Repair of Railway-car Trucks

extends the use of the hoist to any point in the shop or yard where there is a level floor capable of supporting the load. As power is required to lower the hoist, a car can be supported on the hoist without blocking, and left over the noon hour or over night without danger of the load falling.

To remove trucks from beneath a car, two hoists are used at each end of the car. However, in removing one, two, or three pairs of wheels or in renewing springs, only two hoists are necessary. The hoist consists of a motor-driven screw jack mounted in a frame, the jack having three bearing surfaces. A toggle arrangement raises the jack off these bearing surfaces and allows the hoist to be transported from place to place on wheels like a small truck. Several hoists can be operated as one unit when the control is centralized in a single push-button station.

* * *

Nickel anodes, such as are used for replenishing the solution in nickel plating, have formed the subject of a recent investigation at the Bureau of Standards. The purpose was to determine the relative behavior of different forms of nickel, such as electrolytic, rolled, and cast nickel, in the solutions used for electroplating. A study was also made of the effect of impurities, both accidental and purposely added. The experiments showed that the addition of a chloride to the solution caused all types of anodes to dissolve with a high efficiency. The chief difference in the behavior of the different types of anodes was in the uniformity with which they dissolved. Anodes having a relatively high carbon content were found to dissolve more readily than the more nearly pure forms of nickel, about 1.5 per cent of carbon being found satisfactory. Appreciable amounts of sulphur and copper were found to have a harmful effect.

PERSONALS

W. T. HALL, purchasing agent of Brewster & Co., New York City, was elected president of the Purchasing Agents' Association of New York at the last annual meeting.

MORGAN P. ELLIS has been appointed general sales manager of the Economy Fuse & Mfg. Co., Chicago, Ill. Mr. Ellis has been assistant general sales manager for the last eight years.

WILLIAM F. DURAND, professor of mechanical engineering at Stanford University, California, has been nominated for president of the American Society of Mechanical Engineers for 1925.

S. F. JETER, chief engineer of the Hartford Steam Boiler Inspection and Insurance Co., Hartford, Conn., has been nominated for one of the vice-presidents of the American Society of Mechanical Engineers.

EDWARD A. MULLER, vice-president and general manager of the King Machine Tool Co., Cincinnati, Ohio, has been nominated for the office of manager on the council of the American Society of Mechanical Engineers.

HERMAN LEMP, engineer in charge of the internal combustion engine engineering department of the General Electric Co., at Erie, Pa., and for forty-two years associated with the company, has joined the Erie Steam Shovel Co.

C. D. PRICE, who has been connected for many years with the Industrial Works at Bay City, Mich., recently as traveling service engineer, has been appointed district sales manager of the St. Louis district with headquarters at the Railway Exchange Bldg., St. Louis, Mo.

L. D. ALBIN, formerly general sales manager of the Ingersoll-Rand Co., 11 Broadway, New York City, has been elected vice-president in charge of the European sales of that company. D. C. KEEFE, formerly assistant general sales manager, will succeed Mr. Albin as general sales manager.

GUY HUBBARD, of the engineering department of the National Acme Co., Windsor, Vt., has been elected chairman of the Green Mountain Section of the American Society of Mechanical Engineers, which comprises the members of the society residing in Vermont and the western part of New Hampshire.

JOSEPH KAYE WOOD, mechanical engineer, at present associated with the Westinghouse Electric & Mfg. Co., announces that he will open an office as consulting engineer in New York City, on or about September 1. Mr. Wood will handle general consulting engineering work, and will make spring engineering one of his specialties.

E. B. MERRIAM, executive engineer of the switchboard department of the General Electric Co., Schenectady, N. Y., has been elected a member of the board of managers of the American Institute of Electrical Engineers. Mr. Merriam has been a member of the institute for eighteen years, and is a past chairman of the Schenectady section.

EMILE BONNAMY, 22 Avenue Philippe Auguste, (11) Paris, France, formerly technical manager of the firm of Moerch & Roumet, Paris, and for eleven years connected with Alfred H. Schutte in Paris, has established an agency for machine tools and machine shop equipment and wishes to communicate with American firms wishing representation in France.

J. C. MERWIN, works manager of the Chain Belt Co., Milwaukee, Wis., was elected second vice-president of the company at the annual meeting held in Milwaukee in June. Mr. Merwin has been associated with the company since 1917. The other new officers elected were Brinton Welser, secretary, and C. E. Stone, assistant secretary. The officers re-elected were C. R. Messinger, president; Clifford F. Messinger, first vice-president; and C. L. Pfeifer, treasurer.

* * *

THE AUTOMOBILE INDUSTRY

At the World Automobile Congress recently held in Detroit, it was stated that leading manufacturers are aiming for a total registration of 20,000,000 cars in the United States, and that when this figure has been attained, the business will consist mainly of replacements, in addition to whatever expansions may be possible in foreign markets. Present registrations are over 15,000,000, but it is likely that it will take a longer time to reach the 20,000,000 mark than it took to increase registrations from 10,000,000 to 15,000,000. The exports of automobiles from the United States now amount to about fifteen thousand cars a month—a considerable increase over the exports of previous years. The Ford Motor Co. has now built, in all, 10,000,000 cars of the present model T, the first of which was completed October 1, 1908. In 132 working days preceding the completion of the ten-millionth car, 1,000,000 Ford cars were built.

OBITUARIES

HORACE M. SWETLAND

A great executive, whose life was filled with achievements in technical and trade journalism, was lost to his family, friends and business associates, and to a great company of people, when Horace M. Swetland died last month in his seventy-first year. A farmer's boy, his upward career began as a country school teacher, which vocation he followed for eleven years before taking up the calling in which he was to attain so great a success.

Mr. Swetland was president of The United Publishers' Corporation, which owns the largest and strongest group of technical and trade publications in the world, president of The National Publishers' Association, and an official of numerous corporations and associations.

Mr. Swetland was known to his friends and associates and to all who came in contact with him, for his absolute dependability in all business relations, and for his quiet mastery of the great problems he faced and of the innumerable forms of work which he undertook.

Quiet and unassuming, many men have filled a larger place in the public eye; but none deserves a higher tribute to his life and works than Horace M. Swetland.

FRANK B. GILBRETH

Frank B. Gilbreth, one of the best known of the engineers engaged in scientific industrial management work, died suddenly June 14, immediately after a telephone conversation with Mrs. Gilbreth from a telephone booth at Montclair, N. J. Mr. Gilbreth was born at Fairfield, Me., July 7, 1868. He early became actively interested in the Taylor system of management, but he approached it from an independent scientific angle and developed methods of making combined time and motion studies by means of photographs. He had a laboratory in connection with his office where manual operations could be photographed by means of a motion picture camera, and he devised a special clock for measuring very small divisions of time. He made wide use of the motion picture film, of the stereoscopic camera, and of various other optical means in his time and motion studies, and he was also a scientific student of fatigue in industrial work, devoting a great deal of time to methods for eliminating unnecessary fatigue from mechanical operations.

Mr. Gilbreth was a member of the American Society of Mechanical Engineers, the Society of Industrial Engineers, and the Taylor Society. With Mrs. Gilbreth he was co-author of numerous technical society papers and books, including "Time Study," "Fatigue Study," "Applied Motion Study," and "Motion Study for the Handicapped." He is survived by Mrs. Gilbreth, who closely collaborated with him in all his later work, and by eleven children.

FRANK SPALDING, an employe of the Brown & Sharpe Mfg. Co. for over forty years, died in Providence, R. I., on June 8, in the eighty-second year of his age. Mr. Spalding was born in Ashford, Conn. When he was a young man he went to South Manchester and obtained work in the mechanical department of the Cheney Brothers' silk mill, later serving an apprenticeship as a machinist. Having completed his apprenticeship, he went into the employ of the Victor Sewing Machine Co., who in the late eighties brought out the Victor micrometer caliper. This caliper was bought by the Brown & Sharpe Mfg. Co., and Mr. Spalding went to Providence to join the company in July, 1883, remaining with them during the remainder of his active life. Mr. Spalding was a typical New England mechanic, and he has left his mark upon the tools that the Brown & Sharpe Mfg. Co. are manufacturing at this time. His inventions in connection with micrometer calipers marked forward steps in the art.

In a paper read before the New England Railroad Club by James Partington, estimating engineer of the American Locomotive Co., Schenectady, N. Y., it was pointed out that the railroads could greatly improve their maintenance facilities by making a careful inventory of their requirements for repairs and renewals, and then ordering from the original manufacturer of the engines the parts required, whether large or small, if the quantity involved warranted such an order. Doubtless this method would also make it possible to produce repair parts cheaper, because the locomotive-building shop has better facilities for manufacturing these parts than the ordinary railroad repair shop.

The Gears that Count—are the ones that pass inspection

QUALITY

The word "Quality" is hard to define. Yet the quality of Brown & Sharpe Products is easy to recognize. The very appearance of a Brown & Sharpe Product indicates good workmanship throughout. Examine one of our machines, for example, and notice the care each detail has received. This close attention to detail is characteristic of Brown & Sharpe workmanship and represents the high standard of Quality to which all Brown & Sharpe Products must conform.

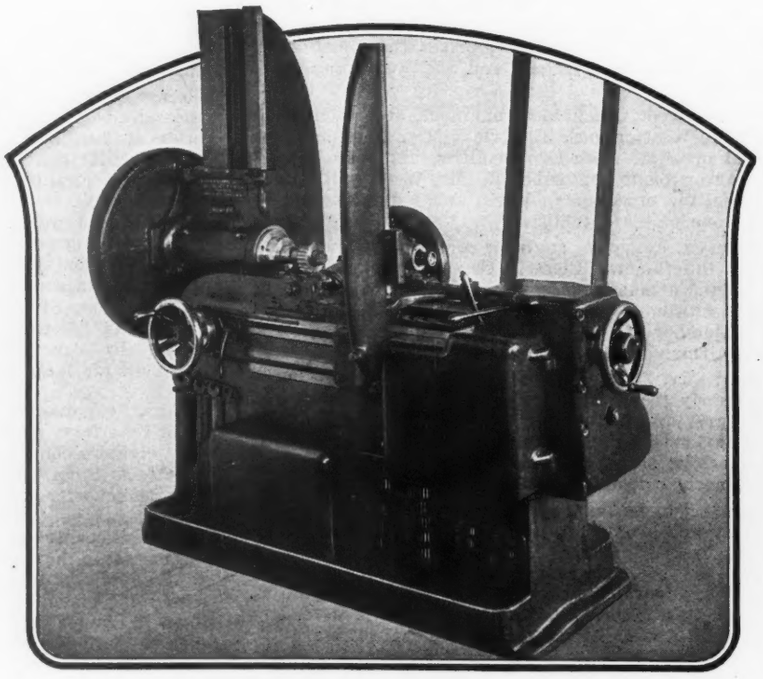
This catalog lists our complete line of Gear Cutting Machines. Five sizes for Spur Gears—two sizes for Spur and Bevel Gears. Read through the specifications of these machines and see which machine meets your requirements. Write today for Catalog No. 137.

The demand today is for Better Gears. Let Brown & Sharpe Gear Cutting Machines help you meet that demand.

On Brown & Sharpe Machines an accurate index wheel of large diameter in proportion to the diameter of the work insures accurate spacing. A smooth, steady cutter drive, insured by a heavy flywheel on the cutter spindle, helps to produce gear teeth with true, even surfaces. Smooth teeth, accurately spaced, are the marks of a high-grade gear.

The rate of production on Brown & Sharpe Machines is consistent with the quality and the finish desired. As to production, we suggest that you measure results in gear work by the number of gears that pass inspection. Brown & Sharpe Machines will bring this total up to a high average. For further facts about these machines, write for Catalog No. 137.

BROWN & SHARPE MFG. CO.
Providence, R. I., U. S. A.



B·S

Machines

Milling Machines
Grinding Machines
Screw Machines
Gear Cutting Machines

BROWN &

Ground-Form Cutters—give better gears and increase production

For Better Gears—because Ground-Form Cutters are accurate. Grinding the teeth on the form corrects all hardening distortions.

For Better Gears—because any Ground-Form Cutter can always be duplicated; this ability to secure duplicates means that you can produce uniform gears in large quantities.

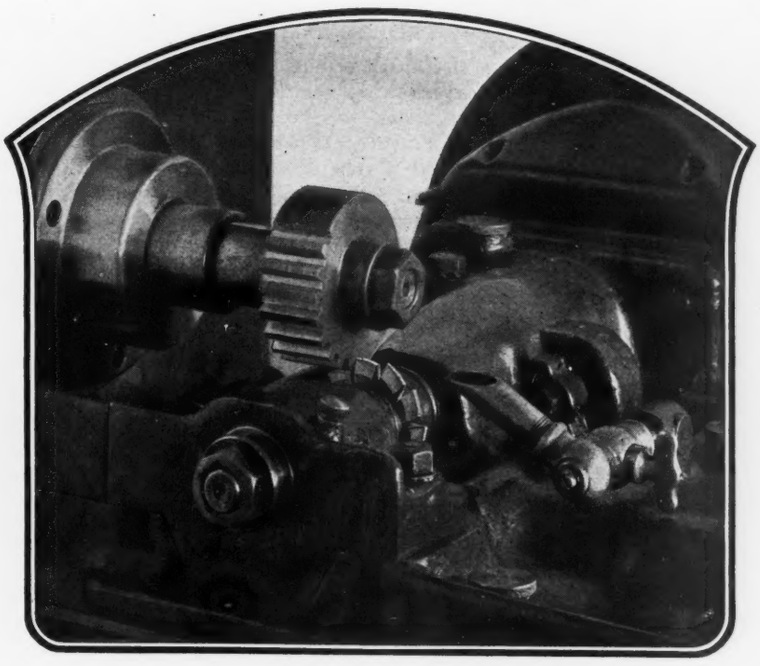
For Increased Production—because Ground-Form Cutters have a free cutting action which allows the use of high speeds and coarse feeds.

For Increased Production—because Ground-Form Cutters work longer between resharpenings. With less time out for changing cutters, each machine produces more gears per day.

Our booklet, recently issued, describes in detail the advantages of using Ground-Form Cutters. Write for your copy today.

BROWN & SHARPE MFG. CO.
Providence, R. I., U. S. A.

Brown & Sharpe Ground-Form Gear Cutters can be secured in sizes from 1¾ to 12 Pitch, inclusive. In addition to Ground-Form Gear Cutters, we also make to order Ground-Form Splined Shaft, Sprocket Cutters, etc. Get in touch with our Cutter Department in regard to Ground-Form Cutters.



This book shows why Ground-Form Cutters give increased production and greater accuracy and uniformity on Gears, Splined Shafts and Sprockets.
Write for your copy today.

B&S

Small Tools
and Milling Cutters; over 2000 of the best you can buy.
Catalog No. 29.

TRADE NOTES

AUTOMATIC MOLDING PRESS Co., Newark, N. J., has moved to larger quarters at 280 Passaic St., Newark, N. J.

WAGNER ELECTRIC CORPORATION, St. Louis, Mo., has removed its Philadelphia office and service station to 1720 Callowhill St. Elmer Lingard continues in charge.

RAMSEY CHAIN Co., INC., 1039 Broadway, Albany, N. Y., has appointed the Morse Engineering Co., 549 W. Washington St., Chicago, Ill., its representative in the Chicago territory.

SERVICE MACHINE Co. announces the removal of its plant to 750 Broadway, Elizabeth, N. J. This firm specializes in the production of special and sheet-metal machinery and dies, and maintains a production department for light machine parts.

LAKESIDE STEEL IMPROVEMENT Co., Cleveland, Ohio, has been organized and has purchased the plant, equipment, and heat-treating business of the STEEL IMPROVEMENT & FORGE Co., located at 5418 Lakeside Ave., Cleveland. The latter company will devote itself to the manufacture of drop-forgings.

BARRETT-CRAVENS Co., 1328 W. Monroe St., Chicago, Ill., is doubling the present capacity of its plant by building four more stories. This additional space has been made necessary by increased business in the Model F lift-truck, which was brought out the first of the year, and the company's new design of portable elevator.

GISHOLT MACHINE Co., 1300 E. Washington Ave., Madison, Wis., has purchased the business of the MILLHOLLAND MACHINE Co., of Indianapolis, including the stock of finished machines, parts in process, good will, trademarks, patents, patterns, drawings, jigs, tools, fixtures, etc. The Gisholt Machine Co. will continue the manufacture and sale of Millholland machines at Madison.

PITTSBURG TESTING LABORATORY is now occupying its new laboratories and office building on Stevenson St. at Locust, Pittsburg, Pa. The building is a five-story, brick-concrete structure, well lighted and ventilated so that all determinations can be accurately performed. Improved types of physical testing machines and chemical apparatus have been installed, and the facilities of the laboratory have been enlarged.

PERSONS-ARTER MACHINE Co., 72 Commercial St., Worcester, Mass., has changed the corporate name of the firm to the ARTER GRINDING MACHINE Co. The change in name is due to the fact that Charles A. Persons severed his connection with the firm, both as an official and stockholder, about three years ago, and it is felt that the new name is more descriptive of the company's product. The officers remain the same as in the last two years, and no change has been made in the stockholding interest.

MORSE CHAIN Co., Ithaca, N. Y., has opened a new sales engineering office at Railroad Exchange Bldg., St. Louis, Mo., under the management of H. E. Haslett. This move has become necessary because of the great expansion of the Morse silent chain business in this territory, and the new office will be in a position to render even greater service than heretofore to silent chain users in that territory. The Morse Engineering Co. will continue its general consulting and contract engineering as heretofore at the same address —Commercial Bldg., St. Louis, Mo.

CHICAGO PNEUMATIC TOOL Co., 6 E. 44th St., New York City, announces the removal of its Los Angeles branch, sales and service headquarters from 307 E. Third St., to the company's new building, 655 Santa Fé Ave. This change has been made necessary by the rapidly expanding business handled from the Los Angeles branch, which serves southern California, southeastern Nevada, Arizona, Lower California, and Sonora, Mexico. The company also announces the opening of a branch office in Dallas, Tex., at 210 S. Jefferson St. J. O. Bailey is in charge of the Dallas office.

BASSICK-ALEMITE CORPORATION, Chicago, Ill., announces the purchase of the ALLYNE-ZERK Co., of Cleveland, Ohio, which will be operated as an independent unit, but under the same general management as the other seven companies controlled by the corporation. The general direction is in the hands of an executive committee headed by E. W. Bassick of Bridgeport, Conn., president of the corporation. E. S. Evans, president of E. S. Evans & Co., of Detroit, one of the subsidiary companies, has been made vice-president of the corporation and will have charge of the sales of all the units.

WILEY MACHINE Co., Los Angeles, Cal., manufacturer of tools, dies, special machinery, screw machine products, and metal stampings, is building a new plant to take care of its rapidly growing business. The first unit of the one-story building is 80 by 100 feet, and provision has been made in the design and lay-out for the addition of a second unit of the same size on the west side of the present building. Hamm & Grant, Inc., industrial engineers, 607 Ferguson Bldg., Los Angeles, have completed the architectural and engineering plans, and have started to erect the building.

J. H. WILLIAMS & Co., Buffalo, N. Y., manufacturer of drop-forgings and drop-forged tools, has completed the transfer of the manufacturing operations of its Brooklyn and Chicago factories to the Buffalo works of the company where all the American manufacturing is now concentrated. District sales offices and warehouses will be maintained after July 1 at 75-77 Spring St., New York City, and 117 N. Jefferson St., Chicago, Ill. E. J. Wilcox will be sales manager of stock in New York, and P. Rigby sales manager of special products for the eastern territory. N. P. Linde will have charge of stock at Chicago and A. C. Nuth of special products for the western territory.

AXLE BEARINGS CORPORATION of New York has been recently organized, with a capitalization of $300,000, to manufacture an axle roller bearing especially adapted for horse-drawn vehicles and platform trucks, etc., to minimize the maintenance expense and the need of greasing. The TEETSOW-DRYSDALE ENGINEERING CORPORATION, 116 W. 39th St., New York City, will have charge of the development of the new bearing, supervising the manufacture and promoting the sales campaign. The management contemplates installing complete equipment and machinery for the production of about 100,000 sets of these axle bearings a year. The plant is scheduled to begin operations next October. The officers are Dr. H. C. Jacobsen, president; W. H. Teetsow, vice-president; Albert J. Clark, secretary; and James B. Stearns, treasurer.

* * *

PROPOSED HACKSAW BLADE SIZES

A meeting of manufacturers of hacksaw blades, representing about 60 per cent of the hacksaw blade output of the United States, was recently held in the Division of Simplified Practice, Department of Commerce, Washington, D. C., with a view to reducing the variety of sizes of hacksaw blades. It was shown that fifteen manufacturers offered 460 sets of specifications in regard to hacksaw blade sizes, and that about 95 per cent of the demand was for 47 of these sizes. The accompanying table shows the 25 hacksaw blade sizes that were recommended for consideration as basic standard sizes.

PROPOSED HACKSAW BLADE SIZES
(All dimensions in inches)

Length	Width	Thickness	No. of Teeth per Inch
8	1/2	0.025	18–24–32
9	1/2	0.025	18–24–32
10	1/2	0.025	14–18–24–32
12	1/2	0.025	14–18–24–32
12	9/16	0.028	14
12	5/8	0.028	14
12	5/8	0.032	14–18
12	3/4	0.032	14–18
14	3/4	0.032	14
10	3/4	0.049	10–14
12	3/4	0.049	10–14
12	1	0.049	10–14
14	1	0.049	10–14
16	1	0.049	10–14
17	1	0.049	10–14
18	1	0.049	10
14	1	0.065	10
16	1	0.065	10
17	1	0.065	10
18	1	0.065	10
20	1	0.065	10
21	1	0.065	10
24	1	0.065	10
18	1 1/4	0.065	8–10
24	1 1/4	0.065	8–10

Machinery

Little Stories of Service and Savings

Where Accuracy and Quality Count!

SACO-LOWELL SHOPS *SAYS—*

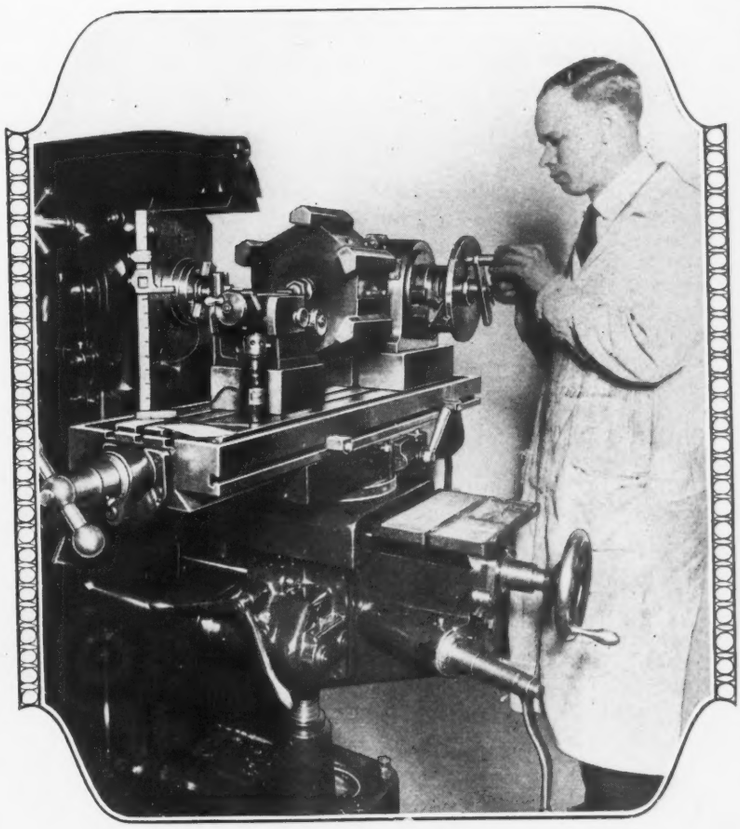
"We appreciate the fact that all of the Cincinnati Milling Machines used at this plant have the advantages of the above mentioned points (ease of handling—rigidity—workmanship), and we feel that we are getting everything possible out of our machines in regard to *accuracy, high quality and maximum production.*"

Ease and speed in operation are important factors in the tool-room. Frequent changes in set-up and repeated changes both for feeds and speeds demand a flexible machine with centralized control which will respond at once to the movement of the operator.

All of these requirements are met by Cincinnati No. 2 and No. 3 High Power Millers.

You will be interested in the story of Cincinnati Accuracy as set forth in the booklet—"Tool-room Methods."

Send for your copy of this 65 page book.



A No. 3 Universal High Power Miller (but one of a large installation of Cincinnati Millers) in the tool-room of the Saco-Lowell Shops, milling a special jig for drilling and tapping parts on cotton slasher.

THE CINCINNATI MILLING MACHINE CO.
CINCINNATI, OHIO

CINCINNATI MILLERS

COMING EVENTS

SEPTEMBER 15-18—Machine tool exhibit at the Mason Laboratory, Sheffield Scientific School, Yale University, New Haven, Conn., under the auspices of the American Society of Mechanical Engineers, Yale University, and the New Haven Chamber of Commerce. Professor S. W. Dudley is in charge of the exhibit.

SEPTEMBER 22-26—Sixth convention and international steel exposition of the American Society for Steel Treating, in Boston. Secretary, W. H. Eisenman, 4600 Prospect Ave., Cleveland, Ohio.

SEPTEMBER 24-25—Automotive transportation meeting at the Society of Automotive Engineers' headquarters, Engineering Societies' Bldg., 29 W. 39th St., New York City. Coker F. Clarkson, secretary.

SEPTEMBER 28-OCTOBER 3—Tenth exposition of Chemical Industries at the Grand Central Palace, New York City. Manager of the International Exposition Co., F. W. Payne.

OCTOBER 3—Aeronautic meeting of the Society of Automotive Engineers at Dayton, Ohio. Secretary, Coker F. Clarkson, 29 W. 39th St., New York City.

OCTOBER 13-18—Twenty-eighth annual convention and exhibit of the American Foundrymen's Association in Milwaukee, Wis. Secretary, C. E. Hoyt, 140 S. Dearborn St., Chicago, Ill.

OCTOBER 22-24—Production meeting of the Society of Automotive Engineers at Detroit, Mich. Secretary, Coker F. Clarkson, 29 W. 39th St., New York City.

NOVEMBER 18-19—Service engineering meeting of the Society of Automotive Engineers at Cleveland, Ohio. Secretary, Coker F. Clarkson, 29 W. 39th St., New York City.

DECEMBER 1-6—Third National Exposition of Power and Mechanical Engineering in the Grand Central Palace, New York City.

NEW BOOKS AND PAMPHLETS

RADIO INSTRUMENTS AND MEASUREMENTS. 345 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Circular No. 74 of the Bureau of Standards.

INVENTOR'S MANUAL—HOW TO MAKE A PATENT PAY. By George M. Hopkins. 128 pages, 4¾ by 7½ inches. Published by the Norman W. Henley Publishing Co., 2 W. 45th St., New York City. Price, $1.50.

This is the third revised and enlarged edition of a book written to serve as a guide to inventors in perfecting their inventions, taking out their patents, and disposing of them. The matter is based on a quarter of a century's experience of a successful inventor, but as the original book was brought out many years ago it has been necessary to rewrite almost the entire text. The revised proof sheets were submitted to a firm of practicing attorneys.

POPULAR RESEARCH NARRATIVES. 152 pages, 4¾ by 7½ inches. Published by Williams & Wilkins Co., Baltimore, Md.

This is a book containing fifty five-minute stories of research, inventions, or discoveries, told in a popular style, with the aim of presenting science as a growing vital thing. The material was collected by the Engineering Foundation, 29 W. 39th St., New York City. Some of the stories relate to the fatigue of metals, electric welding, early uses of nickel, nitrogen, radioactivity, wrought tungsten, the gas-filled incandescent lamp, radium, helium, American glass for safety, measurement of illumination, discovery of manganese steel, bakelite, pattern shop research, malleable iron, and other topics of more general interest.

THE METAL INDUSTRY IN NEW YORK AND ITS ENVIRONS. By Vincent W. Lanfear. 49 pages, 8½ by 11 inches. Published by the Regional Plan of New York and its Environs, 130 E. 22nd St., New York City. Price, 75 cents.

This is the second report in a series of economic and industrial surveys covering the twelve principal economic activities in the metropolitan region. This book deals comprehensively with the metal industry, giving data on its existing location and importance; the growth and movement during the last twenty-five years; and probable future demands of the industry upon location, space, and workers. The report contains considerable valuable material relating to the metal industry in the limited area to which it applies.

THE MODERN EXECUTIVE. Compiled and edited by Daniel Bloomfield. 263 pages, 5 by 8 inches. Published by the H. W. Wilson Co., 958 University Ave., New York City. Price, $2.25

The present volume brings together, from a variety of sources, the best available published material relating to the executive's place in management and how executive ability may be recognized and developed. The aim of the book is to bring out the full significance of modern leadership and to show how much real effort and what kind of effort are needed to make it the indispensable thing that it should be in a business enterprise. The material in this book is brought together under the following headings: Leadership and the Modern Executive; the Place of the Executive in Management; What is Executive Ability?; Developing Executive Ability; the Foreman as an Executive; the Work of the Executive. The book also contains a bibliography on the subject.

ENGINEERING DRAWING. By Thomas E. French. 409 pages, 6 by 9 inches. Published by the McGraw-Hill Book Co., Inc., 370 Seventh Ave., New York City. Price, $3.

This is the third edition of a text-book on engineering drawing. Considerable advances have been made in the methods of teaching drawing since the first edition of this book was written, and in order to bring the text up to date it has been necessary to revise and enlarge both the first and second editions. The present edition contains considerable new material and some changes in presentation have been made, but the general plan is the same. The book contains a collection of tested problems grouped and graded, and following current engineering practice. Many new problems have been added in the present edition. The importance of dimensioning is emphasized by a separate chapter, and a chapter has been added on perspective. One of the other additions is a chapter on charts, graphs, and diagrams, which was necessitated by the growing use of graphical charts in engineering and business.

PRACTICAL CALCULUS FOR HOME STUDY. By Claude Irwin Palmer. 443 pages, 4½ by 7¾ inches. Published by the McGraw-Hill Book Co., Inc., 370 Seventh Ave., New York City. Price, $3.

The author of this book is associate professor of mathematics at the Armour Institute of Technology, and in connection with his work has found a need for a book giving the essentials of the calculus in such a way that they can be mastered without the assistance of an instructor. The present book aims to fill that need and to give the man with limited mathematical training the ability to make use of the calculus as he needs it in his work. The explanations are detailed and complete, and the fundamental questions are repeated again and again so that they will be thoroughly impressed upon the mind of the student. Many illustrations and analogies are included to assist the student in grasping the essentials. The book brings out at the beginning the many helpful uses of the calculus, emphasizing the practical applications of its principles. A large number of problems are worked out, so that the work may be used as a reference and review book.

THE ENGINEERING INDEX FOR 1923. 700 pages, 6¼ by 9¼ inches. Published by the American Society of Mechanical Engineers, 29 W. 39th St., New York City. Price, $7.

This is the 1923 edition of an annual index of engineering literature which covers the entire technical field, including foreign periodicals. In the preparation of the present volume, over 1300 publications have been reviewed, from more than 600 of which articles have been selected for indexing. About 5000 subjects are covered in the 18,000 items which the book contains, and numerous cross-references make it easy for the reader to locate all the articles that deal with the particular problem in which he is interested. The index is arranged alphabetically according to subjects, and under each subject are listed the title of the article, author's name, periodical in which it was published and date of issue, as well as a brief statement of the contents. A list of the periodicals indexed is included, as well as a guide to the use of the book. The general arrangement of this volume is the same as the preceding one except for a slight change which makes it easier for the eye to catch the main headings. The present volume contains 25 more pages than the preceding one.

NEW CATALOGUES AND CIRCULARS

J. C. HAMILTON, 7 Water St., Boston, Mass. Circular descriptive of the "Kon-Ver-Ter" circular slide-rule.

BAUSCH & LOMB OPTICAL CO., Rochester, N. Y. Pamphlet containing list prices of B. & L. photographic lenses and accessories.

CHICAGO PNEUMATIC TOOL CO., 6 E. 44th St., New York City. Bulletin 711, illustrating and describing Crescent vacuum pumps.

UNIVERSITY OF DELAWARE, Newark, Del. Bulletin containing the annual catalogue for 1923-1924, with announcements for 1924-1925.

VACUUM OIL CO., 61 Broadway, New York City. Leaflet outlining the work of the Manufacturers' Service Division of the Vacuum Oil Co.

NEW DEPARTURE MFG. CO., Bristol, Conn. Loose-leaf sheets No. 162-FE, containing data on ball bearing sizes for horizontal electric motors.

WALTER A. ZELNICKER SUPPLY CO., St. Louis, Mo. Bulletin 320, containing data on air compressors and tanks for air, oil, gasoline, and water.

WHITMAN & BARNES MFG. CO., Akron, Ohio. Circular illustrating the use of Whitman & Barnes twist drills in the plant of the Michigan Stove Co.

INDEPENDENT PNEUMATIC TOOL CO., 600 W. Jackson Blvd., Chicago, Ill. Catalogue 14, containing illustrations and specifications of "Thor" universal portable electric drills.

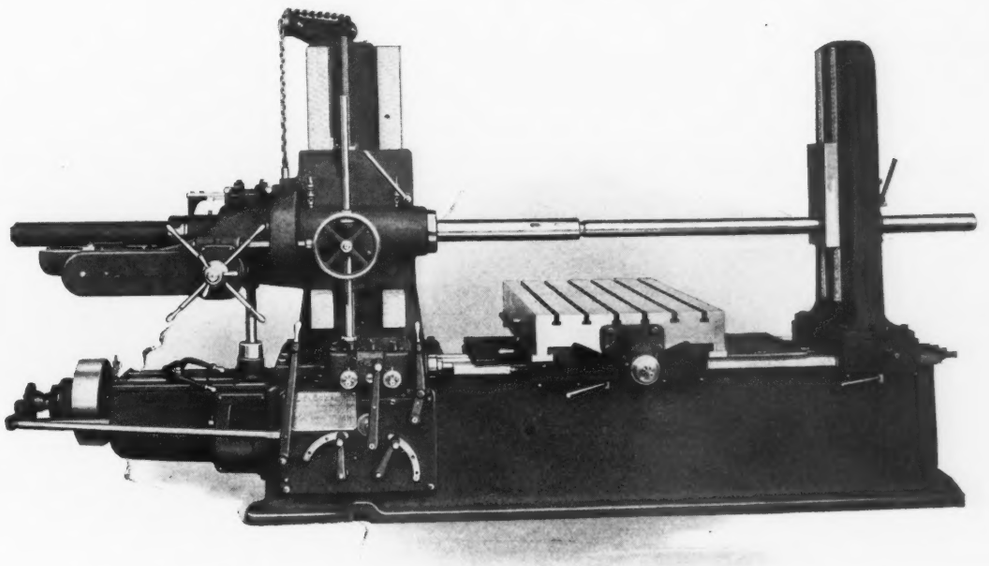
FOXBORO CO., INC., Foxboro, Mass. Bulletin 96, illustrating and briefly describing the different types of indicating, recording, and controlling instruments made by this company.

HANNA ENGINEERING WORKS, 1763 Elston Ave., Chicago, Ill. Pamphlet illustrating different styles and sizes of Hanna air hoists, and containing brief descriptions of each.

INGERSOLL MILLING MACHINE CO., Rockford, Ill. Circular illustrating the use of Ingersoll adjustable-rail milling machines of the planer type for general railroad shop work.

HISEY-WOLF MACHINE CO., Cincinnati, Ohio. Bulletin 1305-A, illustrating and describing the new Hisey 6-inch bench grinder which has been designed for very light grinding operations.

The cost of repairs is part of the cost of production



The

"PRECISION"

Boring, Drilling and MILLING MACHINE

WE ALSO MAKE THE

LUCAS POWER Forcing Press

in your repair shop does the work of several single purpose machines, always as well, usually better, invariably for less investment and therefore more economically.

The cost of repairs on the PRECISION itself is negligible.

LUCAS MACHINE TOOL CO. NOW AND ALWAYS OF **CLEVELAND, OHIO, U.S.A.**

FOREIGN AGENTS: Alfred Herbert, Ltd., Coventry. Societe Anonyme, Belge, Alfred Herbert, Brussels. Allied Machinery Co., Turin, Barcelona, Zurich, V. Lowener, Copenhagen, Christiania, Stockholm. R. S. Stokvis & Zonen, Paris and Rotterdam. Andrews & George Co., Tokyo.

WHITING CORPORATION, Harvey, Ill. Folder relating to the Whiting portable car hoist. Catalogue 172, covering foundry ladles, describing the various types and giving tables of standard sizes.

N. A. STRAND & CO., 5001 N. Lincoln St., Chicago, Ill. Complete catalogue on flexible shafts and equipment, showing many new types which have been added to the line, as well as several new attachments.

VICTOR DIE CASTING MACHINE CO., Ypsilanti, Mich. Leaflets illustrating and describing the Victor die-casting machine, which is made in two standard sizes—the Victor Junior and the Victor No. 2.

CLEVELAND ARMATURE WORKS, INC., 4732 St. Clair Ave., Cleveland, Ohio, is distributing to the trade a descriptive catalogue on the line of grinding, buffing, and polishing machinery made by this concern.

CLEVELAND AUTOMATIC MACHINE CO., Cleveland, Ohio. Production bulletin No. 5, containing production figures and other data relative to specific jobs performed on Cleveland automatics in different plants.

BURDETT SERVICE, St. John's Court at Fulton St., Chicago, Ill. Catalogue of "Burco" products for welding and cutting, containing illustrations and descriptive material covering oxy-acetylene and oxy-hydrogen welding and cutting apparatus.

W. H. NICHOLSON & CO., 112 Oregon St., Wilkes-Barre, Pa. Catalogue entitled "Nicholson Machine Shop Tools—a Trio of Time-savers," illustrating and describing Nicholson expanding mandrels, drill and reamer holders, and arbor presses.

G. A. GRAY CO., Cincinnati, Ohio. Folder containing a list of Gray "Maximum Service" planers that are now in use in railroad shops. The list contains the names of the shops in which the machines are used and the sizes of the machines installed.

GRAHAM MFG. CO., 71 Willard Ave., Providence, R. I. Circular H, descriptive of this company's pressed-steel grinder chucks or abrasive ring holders, which are made in nine sizes to hold 10- to 30-inch rings, and with hubs to suit all kinds of spindles.

MIDWEST AIR FILTERS, INC., 100 E. 45th St., New York City. Booklet containing data on air filters for compressors and internal combustion engines. The principles of air filtration are outlined, and the different types of filters made by the company are described.

STANDARD TOOL CO., Cleveland, Ohio. Pamphlet descriptive of the "Red Shield" high-speed twist drill, a forged drill which is subjected to a special heat-treatment. Sizes and prices are given for the complete line of drills, ranging from ⅛ inch to 3 inches in diameter.

WAGNER ELECTRIC CORPORATION, St. Louis, Mo. Pamphlet containing a reprint of an article from the *Iron and Steel Engineer* entitled "The Motor that Corrects Power Factor," descriptive of the Fynn-Weichsel motor. Pamphlets descriptive of tests made on Fynn-Weichsel motors.

BUFFALO FORGE CO., 144 Mortimer St., Buffalo, N. Y. Bulletin 465, containing complete information on unit heaters and the type of radiation to use under various conditions. The bulletin is illustrated with halftones and drawings of installations, general design, and details of construction.

JOHN BATH & CO., INC., Worcester, Mass. Circular entitled, "John Bath Talks Shop," containing a description of the features of Bath taps, ground from the solid. Two new Bath products are also announced—a high-speed steel ground thread hob, and a high-speed steel thread-rolling die.

E. W. BLISS CO., 53rd St. at Second Ave., Brooklyn, N. Y. Catalogue descriptive of the new Brooklyn plant of the company, illustrated by views of the various departments. Several pages of illustrations are included showing Bliss presses in use on a wide variety of work in various plants.

OHIO CHASE CO., 2094 E. 19th St., Cleveland, Ohio. Pamphlet entitled "How To Order Brass," containing suggestions for specifying what is wanted in buying brass pipe, rod, or sheet. Information is given on what alloy and temper to order, tolerances and size, standard lengths, and packing and shipping.

SHEPARD ELECTRIC CRANE & HOIST CO., Montour Falls, N. Y. Circular illustrating many different applications of the Shepard electric "Liftabout" hoist and floor-operated electric hoists in capacities of over 1 ton. Comparative costs of operation for "Liftabout" hoists and air hoists are included.

BLANCHARD MACHINE CO., 64 State St., Cambridge 39, Mass. Circular descriptive of the Blanchard No. 16-A automatic surface grinder which is designed for the quantity production of small pieces. The two types—hand and magazine—are illustrated, and actual production figures are given on a number of different jobs.

WESTINGHOUSE ELECTRIC & MFG. CO., East Pittsburg, Pa. Circular 1676, describing a new and complete line of interchangeable pipe fittings for structural work and their application. An adjustable insert for fastening machinery or other equipment to concrete walls, floors, or ceilings is also illustrated and described.

LODGE & SHIPLEY MACHINE TOOL CO., Cincinnati, Ohio. Pamphlet entitled, "200 Years," containing an interesting outline of the history and development of the lathe from the earliest crude devices used two hundred years ago to the present highly-automatic types. A few copies of the booklet are available to students or others interested.

KELLER MECHANICAL ENGINEERING CORPORATION, 74 Washington St., Brooklyn, N. Y. Circular illustrating Keller automatic machines for machining irregular formations, contours and cavities in dies, patterns, core-boxes, stripper plates, jigs and fixtures, cams, etc. Milling, drilling and boring can be done at one setting on these machines.

FOOTE BROS. GEAR & MACHINE CO., 232-242 N. Curtis St., Chicago, Ill. Catalogue 24, on Foote IXL gears and speed reducers, illustrating the construction and uses of both spur and worm gear speed reducers. These reducers are made in various sizes, from fractional horsepowers to 150 horsepower in stock size, and in larger sizes to special order.

T. L. E. HAUG, 2315 Durant Ave., Berkeley, Cal. Circulars descriptive of the Haug "one-man" bolt for fitting up steel plate work. This new type of bolt consists of two parts, the key and the bolt body, assembled with a standard square nut, and may be put in place and set up by one man. One of the leaflets contains directions for putting the bolt in place.

CLEVELAND PUNCH & SHEAR WORKS CO., Cleveland, Ohio. Pamphlet entitled "Cleveland and Cleveland Machine Tools," containing a large number of illustrations showing some of the principal buildings in Cleveland, as well as the different types of punching and shearing machines, bending and straightening rolls, presses, etc., made by this company.

BILTON MACHINE TOOL CO., Bridgeport, Conn. Catalogue 2, of the line of milling cutters, small tools, and machine tools made by this concern. Dimensions and prices are given for the various tools shown. The last section of the book contains tables, formulas, and other useful information relating to standard threads, taper shanks, cutting speeds, etc.

CLEVELAND ELECTRIC TRAMRAIL DIVISION OF THE CLEVELAND CRANE & ENGINEERING CO., Wickliffe, Ohio. Catalogue descriptive of the Cleveland electric tramrail system, profusely illustrated with installations of these electric tramrails on a wide variety of work, in machine shops, foundries, warehouses, textile and paper mills, potteries, etc.

WILSON-MAEULEN CO., INC., 375 Concord Ave., New York City. Pamphlet entitled "Solving Production Problems with Rockwell Hardness Tests," showing the use of the Rockwell hardness tester on various classes of work. A letter from a user is reproduced in which the specific savings made possible by the use of this device in that particular plant are described.

INTERNATIONAL MACHINE TOOL CO., Indianapolis, Ind. Circular descriptive of the new 26-inch type C-12 Libby high-power turret lathe. Besides the general description of the different features of the machine, the principal dimensions and specifications are given in tabular form for convenient reference. An index chart is included showing the different feeds and speeds obtainable.

LINK-BELT CO., 910 S. Michigan Ave., Chicago, Ill. Portable Loader Book No. 650, covering the complete line of Link-Belt industrial loaders. Electric Hoist Book No. 580, containing 40 pages of descriptive material and operation data and over 100 illustrations of the Link-Belt line of electric hoists. Locomotive Crane Book No. 670, covering both Link-Belt crawler and locomotive cranes.

MONITOR CONTROLLER CO., Baltimore, Md. Circular descriptive of the new Monitor "Triplock" double-pole switch, which is electrically operated and mechanically locked, and in addition, cuts off its own operating current. This switch is especially adapted for the remote control of lighting circuits and the control of motors operated by tank switches, pressure gages, thermostats, and similar devices.

LEEDS & NORTHRUP CO., 4901 Stenton Ave., Philadelphia, Pa. Catalogue 75, describing an apparatus for the electrometric determination of hydrogen ion concentration. Bulletin 680, illustrating and describing the Macbeth illuminometer for measuring the intensity of illumination. Bulletin 871, dealing with temperature measurements in generators, transformers, and cable systems. Catalogue 90, descriptive of the Hump method for the heat-treatment of steel.

BROWN & SHARPE MFG. CO., Providence, R. I. Small tool catalogue No. 29, illustrating and describing the B & S complete line of over 2000 precision measuring tools, including many tools of new and improved design, and listing the complete line of B & S cutters, which comprises over 45 styles and 3000 sizes of milling cutters, gear-cutters, and hobs. The book also contains tables of weights and measures for handy reference. It is made of a convenient size to slip in the pocket.

JESSOP STEEL CO., Washington, Pa. Catalogue of Jessop's steels, covering carbon tool steels, high-speed steels, alloy steels, stainless steel, rustless iron, die steels, and plate sheet, band and strip steels. Considerable information on the effects of heat-treatment is included, as well as tabular matter covering weights of bar steel, wire gage standards, decimal equivalents, Centigrade and Fahrenheit temperatures, comparative hardness numbers in different systems, etc.

BROWN INSTRUMENT CO., Wayne and Windrim Aves., Philadelphia, Pa., has published a 72-page book containing instructions for the installation and care of thermo-electric pyrometers. Complete information is given regarding the protection of the tubes for thermo-couples, various methods of wiring indicators and recorders, eliminating cold junction errors, installing couples and checking thermo-couples, and wiring, and many other points of interest to the user of this class of equipment.